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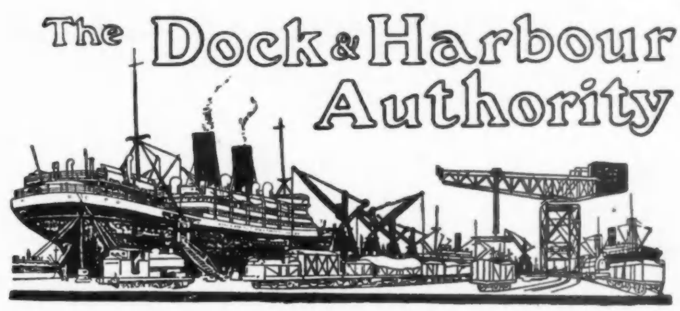

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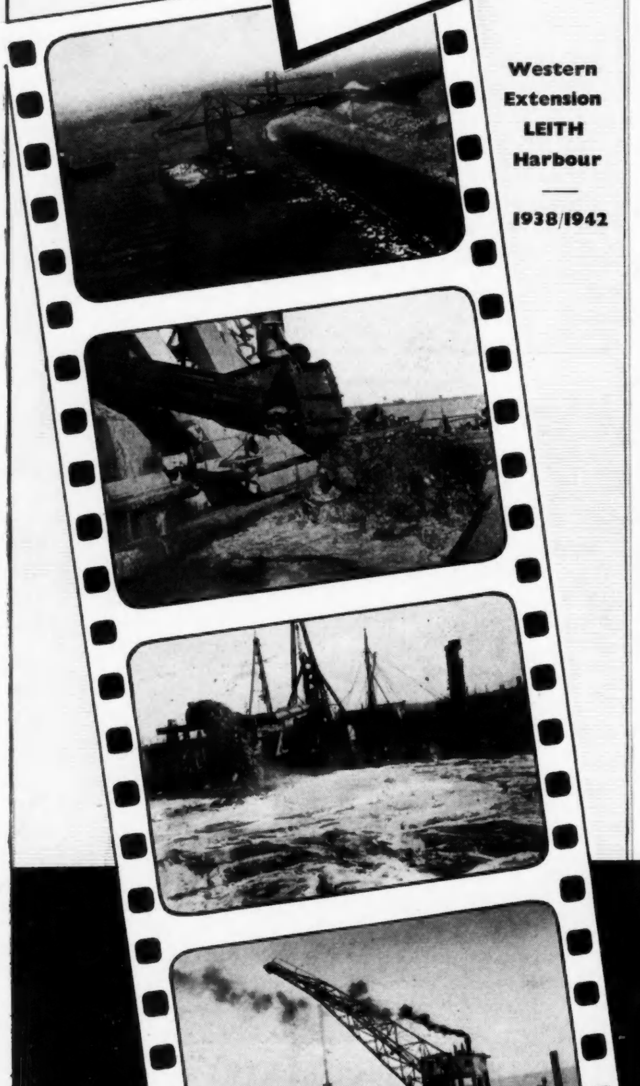

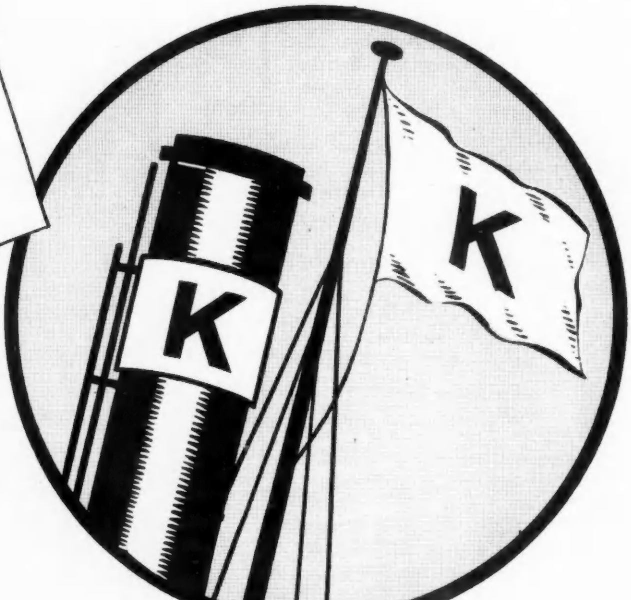
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The Dock and Harbour Authority

No. 356. Vol. XXXI JUNE, 1950 Monthly 1s. 6d.

Editorial Comments

THE PORTS OF ARUBA AND CURACAO.

The group of islands of the Netherlands Antilles comprising Aruba, Bonaire and Curacao, lie about 40 miles off the north coast of Venezuela, and of the three, Curacao and Aruba are the more important. Their surfaces are generally flat, but in the south west of Curacao there are hills attaining an elevation of 1,200-ft. In places, the shores are deeply indented, forming several natural harbours.

Curacao consists of eruptive rocks, chiefly diorite and diabase and is surrounded by coral reefs. Streams are few, and the rainfall is scanty, but although the plains of the islands are for the most part arid wastes, sugar, aloes, tobacco, etc., are produced with much toil in the more fertile glens. Orange peel (for the manufacture of liqueurs), salt, phosphates, cattle, hides and dividivi (used in tanning) are also produced for export.

The chief industry of both Aruba and Curacao is oil refining, the crude petroleum being imported from oil fields of the Lake of Maracaibo in Venezuela. In the former island is situated the Lago Oil and Transport Company's oil refineries—one of the largest in the Western Hemisphere, and in addition, there is the Arend Petroleum Company's refinery with a pier built out into the open sea at the extreme N.W. point of the coast line. Curacao also has a large refinery which is situated in the Schottegat.

The administration of the ports of both islands is undertaken by the Governor of the Netherlands Antilles, assisted by a council of four members and a colonial council of eight members, nominated by the Crown, while the projects for new harbour works were investigated, reported upon, and administered, by a Harbour Commission set up under the auspices of the Dutch Chamber of Commerce.

The article which appears upon another page, and for which we are indebted to a Dutch contributor, reviews the various projects considered for extensions to the harbour of Oranjestad, the chief commercial port of Aruba, and a new harbour in the Schottegat, Curacao. It sets out the technical reasons for the decisions arrived at, as to the types of structure and the materials used for their construction.

The difficulties in the case of Oranjestad, Aruba, consisted in getting a good and suitable quality aggregate for concrete, together with the extreme scarcity of fresh water, and a brief account is given of experiments made with various materials and the use of sea-water. At first, it was thought that explosives would have to be resorted to in removing the hard rock, in order to obtain the necessary depth of water. This was eventually accomplished, however, by a special form of rock-breaker boring tool, and the use of a large cutter dredger.

At the Port of Schottegat in Curacao, due to even greater difficulty in obtaining a suitable aggregate, the quays were constructed with "Senelle" steel piling, which at that time became available, and the only constructional difficulty on these works was the dredging.

Readers will observe that the question of the most suitable position and form of the quays at both ports is discussed, together with the layout of the quays and methods of cargo handling.

In respect to the use of Senelle steel piling, it will be remembered that this piling has very little lateral strength, and the design of a quay with this medium of construction is entirely different from that of the more normal type of steel piling. The question of protection of the steel work was another problem of some importance which was closely investigated before it was finally decided to use the Senelle piling cellular construction for the quay walls in the Schottegat.

In the second instalment of the article, which will appear next month, both the basis of design and the calculation of the cellular quay walls and the protection of the steel against corrosion by the Cathodic System are examined. We are confident that many of our readers will find much to engage their attention in the interesting descriptions of the projects at Aruba and Curacao, relating as they do to ports in a little-known part of the world.

THE INTERNATIONAL ASSOCIATION OF NAVIGATION CONGRESSES.

In this issue will be found the first Report of the British National Committee which was set up in 1947, by the Institution of Civil Engineers, as a British sub-organisation of the Permanent International Association of Navigation Congresses. This Association is, of course, only one of many International Congresses devoted to technical subjects, and while the majority of them are principally concerned with engineering, other interests are often intimately connected. The ground covered by the International Navigation Congress embraces a wide range of subjects of particular interest to all connected with Docks, Harbours and Inland Waterways, whether they be engineers or concerned with the transport of cargoes or the operation and management of ports.

In a world in which distances are becoming less important by reason of better travel facilities and means of transport, nations are tending to be more dependent upon one another, so that improved international relationships are of the greatest importance. An interest in the work of fellow engineers and scientists in these days of keen competition has therefore become essential, and in recent years considerable advances have been made towards closer collaboration, through the medium of various International organisations.

Editorial Comments—continued

It seems hardly necessary to comment upon the advantages to be gained by the sharing of experience and the results of research, for it is obvious that they cannot be anything but beneficial to the particular subject of enquiry. Where the subjects covered by this Journal are concerned, comparative port study in all its branches and an exchange of knowledge and data may tend to effect some degree of uniformity in the essentials of port facilities, and lead towards the quicker turn-round of vessels, a matter of the first importance.

For many years *The Dock and Harbour Authority* has recognised the value of a wide exchange of accumulated knowledge and experience, and in accordance with this policy, recently published a review of the papers presented to the XVIIth Congress of the Association, and will continue from time to time to publish individual papers of general interest. In this issue, for example, readers will find an interesting article on Pneumatic Locks, which is worthy of careful study.

The International Navigation Congress takes a premier place among Technical Associations in providing facilities for submitting papers, and for meeting professionally and socially to discuss problems of mutual interest. Membership is open to all individuals or corporate bodies, and full details may be obtained from the Institution of Civil Engineers, Great George Street, London, S.W.1. Attention is especially drawn to the forthcoming Annual General Meeting of the British Section which will be held on Thursday, 22nd June, 1950, at 4.30 p.m. at the above address.

DOUBLE TAXATION AND FOREIGN CONTRACTS.

The pernicious effects of double taxation have been exemplified by the announcement early last month that two British firms, Sir Lindsay Parkinson & Co., Ltd., and John Mowlem & Co., Ltd., had found it necessary to withdraw their tenders for the contract for the development of the Port of Colombo.

Where no double taxation agreement exists, profits are taxed at source, and again in the country to which they are remitted, and at present Ceylon is not included among the countries with whom agreement has been reached.

In addition to the two British concerns, tenders were submitted by French, Dutch, Danish and American firms, and it has now been announced that the contract has been awarded to Etablissement Billiard and Schneider of Paris.

The whole project for the improvements at Colombo, including the mechanical equipment, is in the region of six million pounds sterling, and the withdrawal of the British tenders is very unfortunate, particularly as Britain's earning potential is already declining in many places abroad because of the industrial development of those countries which hitherto have relied on the enterprise and engineering skill of British firms.

We understand negotiations are now proceeding between the United Kingdom and Ceylon over the whole question of double taxation, and it is to be hoped that a satisfactory agreement will be reached without further delay, and that similar arrangements will be made with any other countries who may be placed in the same position.

THE MECHANICAL HANDLING EXHIBITION AND CONVENTION.

The full programme has now been announced for the Convention which is to be held at Olympia, London, from June 6 to 17, concurrently with the Second Mechanical Handling Exhibition. This, it is claimed, will be the world's largest display of labour-aiding equipment, and will occupy an area more than twice as large as the first exhibition which was held in London in 1948.

Papers to be discussed at the morning or afternoon sessions of the Convention include the use of jib cranes for high speed handling of cargo at docks, the usefulness to contractors of mobile, tail-type jib cranes and derricks, British practice covering electrical equipment on cranes, screens and feeders, goods and package handling, storing and reclaiming materials, elevators and skip hoists, with particular application to the handling of bulk materials.

As was pointed out in the report published by the Anglo-American Council on Productivity on May 19, material handling can account in some industries for as much as 85 per cent. of the cost of the finished product, and this report, as well as the report of the Working Party on Increased Mechanisation in British Ports, published on May 26, will be discussed at the Convention by all sections of industry. The method of introducing new equipment, overcoming workers' prejudice and adjusting wage rates, have been among the most important problems in extending the use of mechanical aids, and this also will be considered jointly for the first time by manufacturers and users of the equipment, including trade union representatives.

Industrialists and students of labour problems will be attending from 28 overseas countries, and more than 170 British firms will be exhibiting their products. Brief details of the exhibits of a number of our regular advertisers will be found elsewhere in this issue.

It is to be hoped that the organisers of the exhibition will be successful in their object of helping home industries, and also increasing the country's exports abroad.

MECHANICAL HANDLING IN PORTS.

As mentioned above, the Report by the Working Party on Increased Mechanisation in the United Kingdom Ports was issued towards the end of May, too late for full details to be included in this issue.

Briefly the Report says that the efficient use of equipment should be settled on a national basis by both sides of the industry, and no large-scale development is likely until this is done.

It recommends that a national survey should be undertaken on the possible effect on the dock labour force of the full use of existing mechanical aids, and says that at present there exist many practices prejudicial to the use and extension of the use of mechanical equipment, which in many cases have been brought about as a result of conditions in the port industry in the days before decasualisation of dock labour.

Largely these practices are regarded by the men as a protection against unemployment, but they have the effect of making the cost of various port operations uneconomic and uncompetitive. Further, they must inevitably add a charge to many commodities passing through the port.

There can be no doubt that the question of mechanisation at ports is a subject of world-wide interest, and accordingly we hope to refer to the matter again, in greater detail, in our next issue.

LONDON STEVEDORING CO-OPERATIVE PLAN.

A venture which is likely to prove of considerable interest from a point of view of industrial relations in the dock labour world is the formation, in the Port of London, of a Master Stevedoring firm, to be run on a co-operative basis.

The scheme is the suggestion of a Catford stevedore and, if successful, it is hoped it will do away with many of the disputes concerning pay rates for dirty, difficult or unpopular cargoes, which arise so frequently in the docks, as it is argued that the members will be working for themselves and so are likely to be more reasonable about their working conditions.

The proposed title of the Company is The London Associated Stevedores, and originally the plan was to start with 1,250 members, each contributing £4, which would provide an initial capital of £5,000. Subsequently it was decided to increase this amount, and if approved by the members at a further meeting, the capital will now amount to £8,000, being contributed by 2,000 members, each of whom would hold sixteen 5s. shares.

It is reported that rapid progress is being made in the formation of the Company, and it is expected all formalities will be completed to enable it to start work by the end of July. Solicitors have drawn up provisional articles of Association based on views expressed at the early meetings, and the document is now being studied by counsel.

Shareholders will be limited to the National Amalgamated Stevedores and Dockers, and it is hoped that one result of the venture will be to improve working relations between stevedores and dockers, especially in the summer, when extra traffic makes it necessary for dockers to undertake work which stevedores normally do.

The New Harbours of Aruba and Curacao

A Review of the Projects at Oranjestad and Schottegat and the Special Types of Concrete and Steel Cofferdam=Walls adopted

By J. F. GROOTE

GENERAL SURVEY

THE ports of the two largest islands of the Netherlands Antilles are amongst the busiest in the world. This is chiefly due to the existence of three oil refineries on the islands, the building of which began in 1915 in Curacao, and in 1924 in Aruba.

After a modest beginning, two of these factories, the Curacao Petroleum Industry Co. in Curacao and the Lago in Aruba, expanded rapidly and with the growth of the refineries, the tanker fleet developed, which brought about more and more traffic in the ports of Willemstad and St. Nicolas (Aruba). The crude oil is imported from Venezuela and large ocean tankers deliver the oil products to the other continents. Thus, whilst there is an even balance in the kind of traffic to and from both islands, the actual goods transport has developed in an entirely different way.

The natural harbour of Curacao, the Schottegat with its navigable route, the St. Annabay, has been for centuries one of the most important ports in the Carribean Sea. This port has shared the vicissitudes, the wealth and poverty of its island, but has nearly always been a transit port besides being a provision port. The Curacao business men were not likely to let their chances slip by; and where necessary, quays and landing stages were built, albeit devoid of any trace of luxury. Moreover, some years ago the Government was in financial difficulties and gradually a situation arose whereby most quays came into the hands of private owners.

In comparison, the harbour of Aruba, and mainly Oranjestad, played a far more modest role; it was little more than a provision harbour. This island, which had only 9,349 inhabitants in 1898, which decreased to 9,075 in 1918, therefore required only a small harbour. The possession of quays and landing stages was consequently not profitable and private business men refrained from any activity in this field. However, with the building of the oil refineries came the swift development of the island. Although they were building their own business harbours here, as in Curacao, these trade harbours did not satisfy the most elementary needs.

In 1931 a new pier was built in Oranjestad, which is still in use, as well as a quay (150 m. long × 6 m. wide), and in 1938 and 1939 the sea approach to this pier was considerably improved.

In spite of these improvements, however, the requirements of Aruba's industry were by no means fulfilled. When, during the war, prosperity reached a hitherto unknown level, it was realized in Aruba that substantial sums would have to be allocated by the Government treasury to give Aruba lasting security, which could later become a source of income in case the oil industry should become less profitable.

This island, which was now playing an important role in this part of the world, and had risen from a needy to a prosperous island, with a population five times its original number, felt it was being placed in the background as regards Curacao. The improvement of the harbour of Oranjestad was therefore one of its foremost aims. A good harbour would attract a great deal of the transit traffic in the Carribean Sea to Aruba, and give a prospective view of passenger steamers with their dollar spending tourists.

The Administrator of Aruba formed a Harbour Commission in June, 1945, which was ordered to draft a plan for a new harbour, and as early as the 6th October of the same year, a report and a project were submitted by the Commission. At an important meeting on the 6th August, 1946, the promise was made by the Governor, Dr. P. A. Kasteel, for the requested harbour of Aruba. One has to remember that the circumstances warranted such a decision to construct the harbour before any detailed scheme had been considered technically. It was later on repeatedly altered and enlarged.

In Curacao there was also discontent as regards the state of the harbour and quays. The owners of the wharves had drawn up a plan years ago for the extension of the so called Prins Hendrik-

Aerial view of first and second basins, Aruba. Work in progress.

Block setting in progress by floating shearleg, crane and divers.

wharf, but they had not yet started executing this work. The main objections brought forward against the existing position were as follows:—

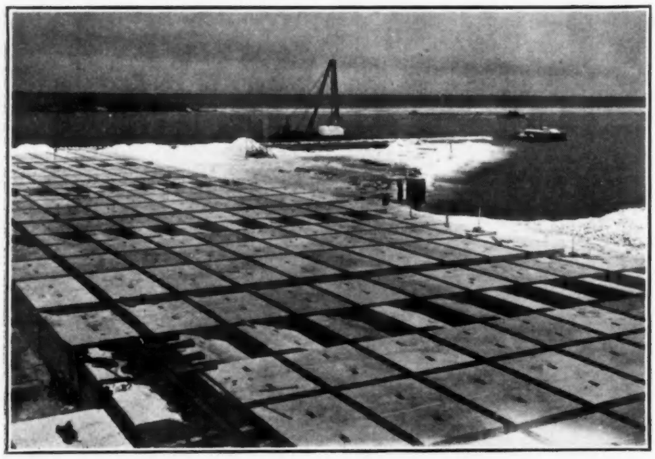
The quays were in the hands of private ownership and the authorities had therefore little influence on the trade, which was of such great importance to the welfare of the island.

The quays, which stretched along either side of the St. Annabay, offered no opportunity for the most economic handling of goods; largely due to general inadequacy of the facilities and the lack of efficient mechanical equipment.

The St. Annabay has a width of 300-ft. and is the traffic route for the steadily increasing shipping, but it was stated that the danger had arisen of collisions with moored ships, also that the quay length is insufficient.

New Harbours of Aruba and Curacao—*continued*

Discussions concerned the size and place of additional quays, as it was agreed that something had to be done. Two schemes were put forward; a modest one, suggested by the privately owned Curacao Harbour Co., for the building of the Beatrixpier next to the Prins Hendrikwharf, and a more ambitious plan drawn up by the Harbour Commission, which, at the request of the Chamber of Commerce in 1946, was set up by the Department of Public Works. The details of these schemes and how the latter one was finally chosen will be considered later. Before doing so, however, it would be useful to furnish some details about the extent of the harbour traffic on both islands.



View of block yard, floating shearleg crane carrying a 59 ton bottom block and in the background the outer reef protection of the harbour.

SHIPPING MOVEMENT

A synopsis of the shipping movement on both islands is set out hereunder.

	Curacao.		Aruba.	
Year	Number	B.R.T.	Number	B.R.T.
1902	1.433	417,810	unknown	
1912	1 428	926,911	"	
1922	2,423	1,935,843	321	33,000
1927	5,530	12 078,777	1,754	3,600,000
1930	7,690	20,234,770	4.321	12.215 304
1932[1]	5,077	17,998,824	3,640	11,239,329
1937	6,496	23,058,007	5,776	21,000,153
1942	4,524	17,465,487	3,606	11,679,969
1943	5,320	17,878,874	5 824	18 387,537
1944	5,567	20,467,351	6,572	23,423,469
1945	6,231	24,294,619	6,958	25,405.234
1946	7,025	29,024,791	6,800	31,524,312
1947	8,296	37.267.594	8,345	35,244,004
1948	9,604	45,646,027	—	—

[1] Crisis.

Although there is little difference between the total figures of Aruba and Curacao, there is a vast difference in the number of merchant vessels entering St. Annabay in Curacao and the number of ships harbouring in the Paardenbay of Oranjestad, Aruba.

	Schottegat, Curacao.		Paardenbay, Aruba.	
Year.	Number	B.R.T.	Number	B.R.T.
1938	1.287	4,486 787	390	654 861
1939	1,219	4,335,776	405	677 949
1940	824	2,434,722	265	444,052
1941	723	2,444,468	206	324,073
1942	377	2,133,166	107	229,192
1943	298	687,103	90	164,425
1944	343	721,740	137	156,202
1945	421	1,016,769	139	124,262
1946	825	2,669,051	200	261,519
1947	1,157	5,211,503	227	408,279
1948	1,446	7,222,152	284	487,792

To compare these figures with those of other harbours which have been given in N.R.T., one need only multiply the figures given under B.R.T. by **0.57**.

The rapid recovery, both after the crisis of 1932 and after the war, attracts attention and inspires confidence. The figures confirm the preceding remarks about the difference in the kind of traffic of Aruba and Curacao.

THE HARBOUR OF ARUBA

SITE AND SCOPE OF PROJECT.

At a distance of approx. 830-ft. from the coast there exists an elongated reef which acts as an efficient protection against wave-action.

As mentioned above, Aruba was not satisfied with the improvement of the harbour entrance in 1938/9, for the depth of the water was not improved. The sole (East) passage through the reef was only deepened and enlarged, and a swinging basin dredged between the landing stage and the reef. The main cause for these restrictions was, no doubt, a financial one. It was now desirable to obtain in the first place another navigable passage, by which the ships could go in and out of the harbour. And in the second and third place, a longer quay and greater depth of water alongside were required. The scheme of the Aruba Harbour Commission consisted of the provision of a western passage, the construction of a quay 450 m. long and 10.5 m. wide, to extend the existing landing stage, and at the same time to use the spoil obtained from the dredging for the reclamation of land in the vicinity. The cost of this scheme, including some additional works, was estimated at Fl. 3,800,000. Fig. 1 shows the plan as ultimately executed.

After Governor Kasteel had adopted the scheme, the Public Works were charged with the detailing and execution of it. It was, however, stipulated that, when working out the details, the original plan was not to be altered basically. After the first credits were granted, prevailing circumstances enabled an early start of the dredging works to be made.

A large cutter dredger (capacity 2,500 h.p., producing sometimes 18,000 cubic metres per 24 hours) owned by the Standard Dredging Co., of New Orleans, had just become available after the completion of work for the Lago Oil Company. Owing to this situation, an advantageous offer was made by the Company, which we felt it our duty to accept. The time for preparation had been very short and we were not certain whether the Harbour Commission's scheme was the best one. Therefore, in the dredging contract as well as in the later estimate for the building of the quay, considerable latitude was left for any eventual changes during execution of the work. This was a very useful stipulation, because soon various important objections were raised against the project. These were mainly caused by the position of the projected quay, which was at an angle of 45° with the prevailing trade wind.

There were many opinions as to proposed alterations and the day on which a decision had to be taken was drawing near. At this juncture the Governor consented to invite, at my request, a Dutch expert, whereupon we were visited by Jhr. Engineer F. van Heemskerck van Beest, Director of Public Works in Amsterdam. He saw no objection to the building of the quay as suggested by the Harbour Commission, since the vessels entering the harbour were only of average size. It was decided, however, that provision should be made for larger vessels, as can be seen from the proposed increase in the depth of the water. It seemed, therefore, that when the plans were originally drawn it was not realised that, besides an increase in the number and size of vessels, larger ones also were to be expected in Oranjestad. The wind can blow very strongly in Aruba and therefore van Heemskerck considered that, without the aid of tugs, ships of 10,000 tons or more might get into difficulties when mooring. After further consideration, he suggested that the scheme should not be altered (borings showed that the soil behind the quay consisted of hard chalk rock, which would be extremely expensive to remove). He did, however, suggest a supplementary project for the N.W. side, consisting of a pier situated in the direction of the wind (Fig. 2). He estimated the cost of this additional work at Fl. 2,500,000.

The project put forward by van Heemskerck was at first accepted by the Harbour Commission, but after his departure and before the necessary credit was granted, a new point of view arose. We

New Harbours of Aruba and Curacao—continued

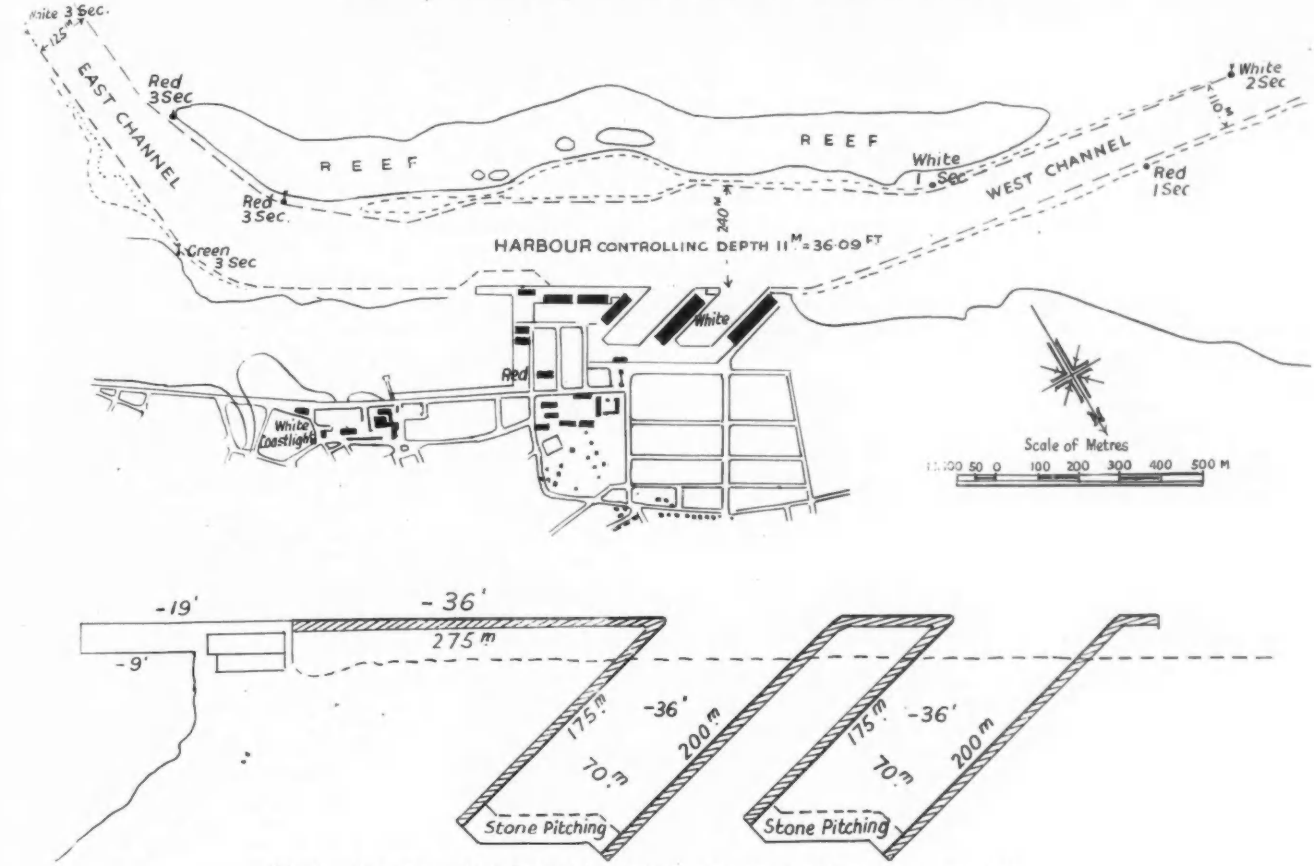


Fig. 1. Extensions at the Port of Oranjestad on the Island of Aruba as constructed.

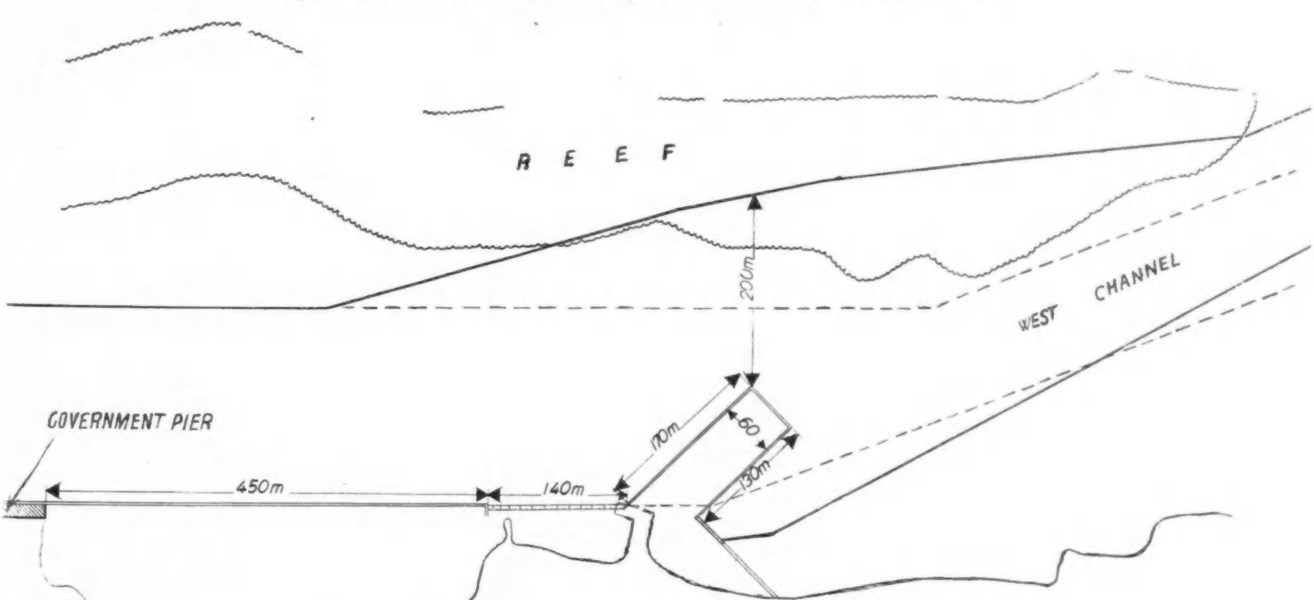


Fig. 2. Scheme of van Heemskerck afterwards modified.

New Harbours of Aruba and Curacao—continued

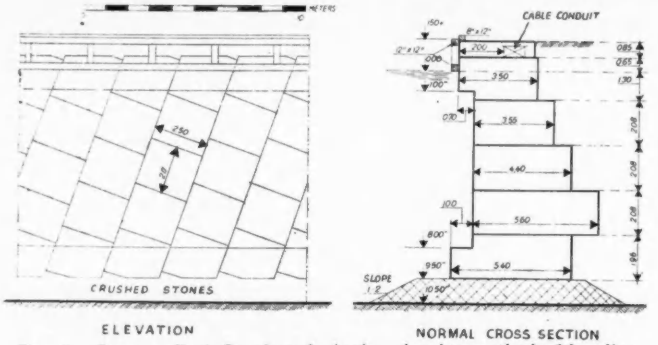


Fig. 3. Quay wall at Oranjestad, Aruba, showing method of bonding blocks.

requested the Standard Dredging Co. to thoroughly examine, once more, whether it was really impossible to remove the rock mentioned above with their giant cutter-dredger. This new investigation had a surprising result. Hitherto we had been drilling the very hard rocks with rotary drills and brought out of the casing cores which seemed to prove that little could be achieved without explosives. The American Company, on the other hand, examined another possibility, viz., what effect a small cutter of similar design would have. A seamless 2-in. pipe, thickness 1-in., with a chisel-like cutting edge, was alternately jabbed and rotated into the rocks, which were crushed into a coarse kind of chalk sand and could then be readily taken up by the large cutter dredger. Under these circumstances it was thought worth while to reconsider the scheme, and the Department of Public Works proposed, after consultation by correspondence with Mr. van Heemskerck, a new project (Fig. 1) which afforded more mooring space in the wind direction and which offered, at the same time, a more compact and easily operated harbour. This last plan was finally accepted and is now in execution.

From dredging work already completed, the opinion of the Standard Dredging Co. has proved to be correct, although the rate of production was reduced to one third and the price therefore was approx. threefold, viz., F. 2.77 per cubic metre. The quay walls constructed by the Netherlands Harbour Works Co., Ltd., are almost completed, and at the time of writing it has not yet been decided whether the western basin will also be provided with quays at this juncture.

THE CONSTRUCTION OF THE QUAYS.

As will have been seen from the foregoing, the development of the schemes was not only influenced by technical considerations,

Fig. 4. The Schottegat on the Island of Curacao, showing site of new works.

but the relations between Curacao and Aruba also played a part. The choice of quays was influenced by entirely different circumstances; for example, the acquirement of heavy steel sheet piling was impossible at the beginning of the work. Out of the reclamation, however, enormous amounts of sand mixed with stone chips were made available. Should it be possible to prepare a satisfactory concrete with the aid of this sand, then the construction of a wall out of mass concrete would be feasible. This possibility was investigated and, although with rather primitive methods, it gave a positive result. It aimed mainly at obtaining solutions to the following problems:—

(a) Was there a difference in quality between concrete made with dredged coral sand (so called salt water sand) and sand found elsewhere in Aruba (so called fresh water sand)?
(b) Was it advisable to mix the concrete with sea water or was it necessary to use the scarce distilled water?
(c) What proportion of crushed stone (chalk stone crushed on the island) had to be added?
(d) What ratio of cement (blast furnace cement) could be considered sufficient?
(e) What was the correct proportion of water?

It was to be noted that the cubes were for practical reasons 30 × 30 × 30 cm. and that the results, to compare them with the 20 cm. cube mentioned in the concrete standards, had to be multiplied by 1.10 (according to investigation by Gehler, Burchartz).

At first it was observed that the results from salt water and salt water sand were the more favourable. The quality and granulation of the salt water sand is indeed better than that of the fresh water variety and it was therefore decided to make use of it. The advantage which the samples made with salt water showed after seven days was, in some cases, reduced after 28 days. We therefore considered the use of sea water too risky. The contractor was quite convinced about it and offered to supply the fresh water without any additional charge. Finally, a test was made to compare cubes of concrete composed of 250 kg. blast furnace cement, 760 litres coral sand, 550 litres crushed stone and 200 litres fresh water with cubes of concrete containing 350 kg. of cement in the same proportion all per m^3 concrete. The first concrete showed a compressive strength of 177 kg./cm^2 and the second 204 kg./cm^2; both on cubes 20 days old.

Owing to this favourable result we decided that the application of more than 250 kg. cement per m^3 for this non-reinforced heavy concrete was not necessary. 100 kg. more meant, after all, an extra expense of about F. 165,000.

At a first glance the proportion between sand and stone-chips may seem surprising. For a heavy concrete wall the quality was considered sufficient, but not for the making of reinforced concrete.

Tenders were invited and on the basis of an estimate for a wall consisting of concrete blocks, the construction was then allocated to the Netherlands Harbour Works Co., Ltd. Section and elevation of wall are to be seen in Fig. 3.

These blocks are placed on crushed stone, about 1 m. thick, levelled by divers. The blocks are first poured and vibrated in removable moulds, then brought to the water front by rail, where heavy floating shear legs lift them from the lorry, whence they are sunk under water and placed in position. The heaviest block weighs approx. 60 tons.

On top of the block wall a 1.50 m. thick reinforced concrete coping is placed, with a cable trench formed in it, bollards to resist about 30 tons being fixed in the coping.

THE HARBOUR OF CURACAO

SITUATION AND SCOPE.

In March, 1945, I offered the Governor plans for the extension of Curacao and drew attention to several important points with regard to the harbour problems.

On the ground of these considerations and figures it was necessary to examine, when planning the expansion, whether the loading and unloading quays along the St. Annabay should not be omitted. To allow the projector freedom in his plans to design

New Harbours of Aruba and Curacao—continued

an entirely new harbour and pier combination in the Schottegat, for his practical sense would object to drawing up elaborate plans, involving extremely expensive appropriations, with an eye to the distant future, but would rather make a practical proposition for the immediate future.

I have already mentioned that the harbour project was not accepted without some argument and that the wharf owners were supporting a different scheme. Where the St. Annabay changes to Schottegat, the Prins Hendrikwharf is situated on the west side. The opposing scheme consisted of the enlargement of this wharf by the construction of the Beatrixpier.

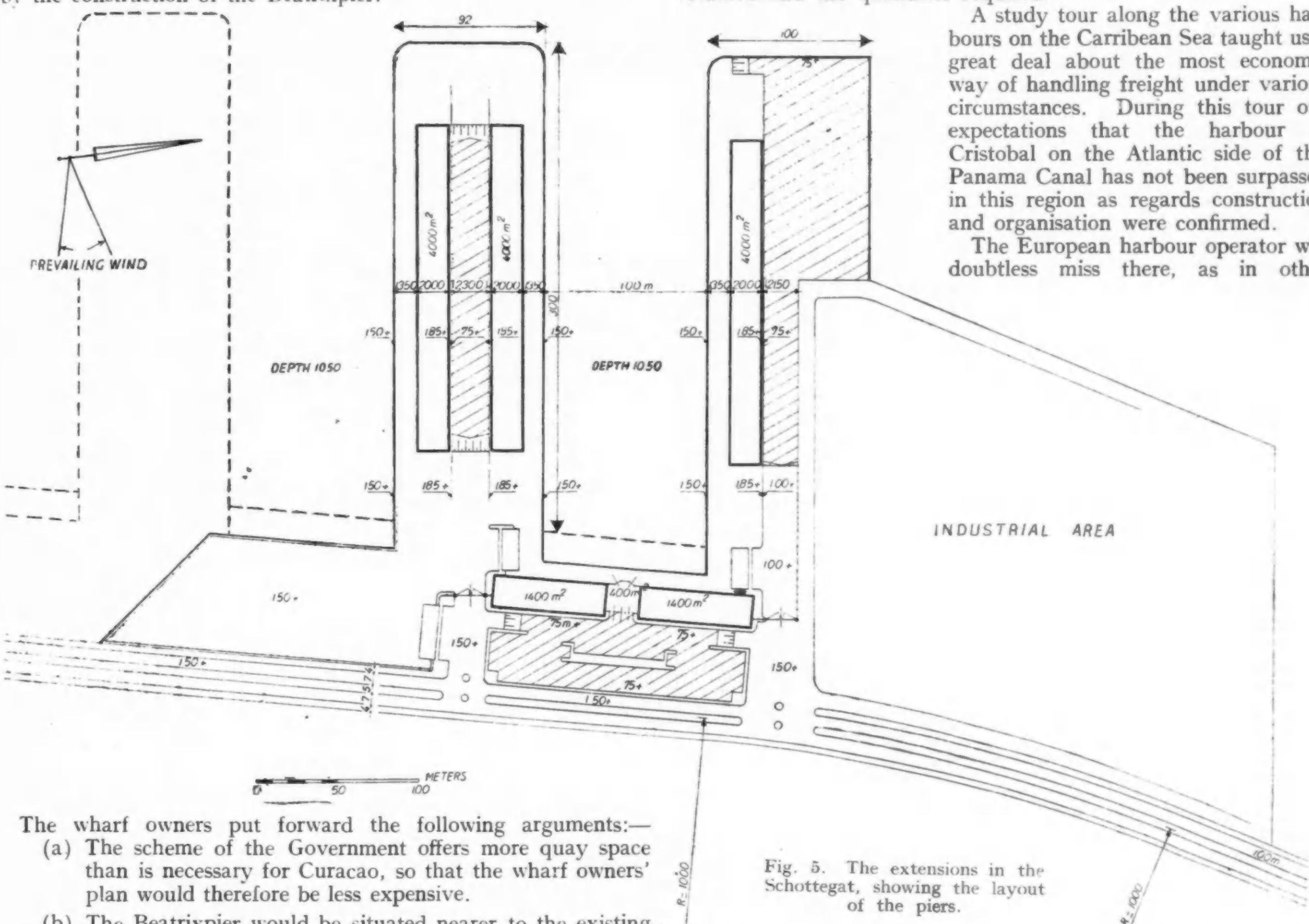


Fig. 5. The extensions in the Schottegat, showing the layout of the piers.

The wharf owners put forward the following arguments:—

(a) The scheme of the Government offers more quay space than is necessary for Curacao, so that the wharf owners' plan would therefore be less expensive.

(b) The Beatrixpier would be situated nearer to the existing wharves. The harbour company also wished to improve the so-called New and Motet wharves, along the St. Annaby.

The aforementioned Harbour Commission set up by the Chamber of Commerce wished however, after mature deliberation, to carry on, and was of the opinion that should the new plan be acceptable, freeing the St. Annabay of harbouring ships had to be taken into consideration. This would mean a complete revision of the Parera plan, as accepted in the expansion plan. When studying this request of the Commission, we were visited by Jhr. ir. van Heemskerck with regard to the works in Aruba. The opportunity for Curacao of profiting from his experience and knowledge was seized upon and the new plans were developed after due deliberation with him. The North and West of Schottegat were mainly taken up by the CPIM (for site plan see Fig. 4); for a large scheme, as was now suggested, only the East side offered sufficient space, as, on the whole, the water was rather shallow, so that considerable dredging work would have to be undertaken. Upon examining the soil, it was found that it could be dredged, though perhaps with difficulty. Apart from mud and coral, which sometimes formed large lumps, a blue diabase is found there, which is the hardest stone found in Curacao. On the surface it is generally soft, i.e., weather beaten, but beneath the water's surface, completely protected from the weather, it was perfectly sound. During the execution of the dredging work it was found that the rock-dredger (bucket size 800 litres) could only produce 40% of its normal quantity.

From the collected details it was calculated how much good soil could be dredged which would be suitable for filling up of harbour sites. The results here were satisfactory and it seemed that an even balance could be expected between the quantities obtained and the quantities required.

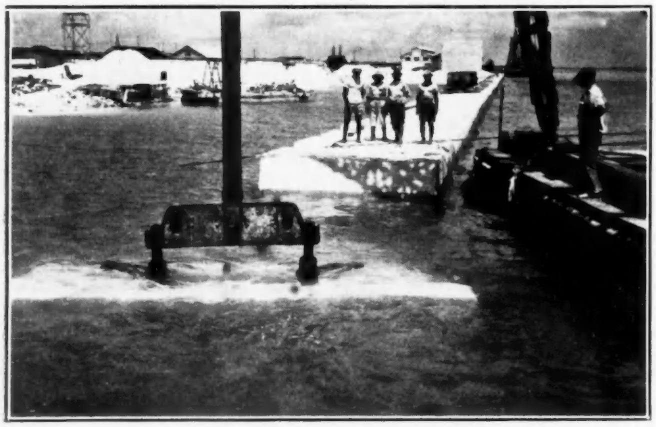
A study tour along the various harbours on the Carribean Sea taught us a great deal about the most economic way of handling freight under various circumstances. During this tour our expectations that the harbour of Cristobal on the Atlantic side of the Panama Canal has not been surpassed in this region as regards construction and organisation were confirmed.

The European harbour operator will doubtless miss there, as in other American harbours, the large cranes existing in Continental ports, but will have to admit that the Americans have instead other practical mobile machinery, and attach more value to the lifting machinery on the ships than is usual in Europe.

Although we are allowing for the possibility of placing cranes, the navigation experts, particularly the Royal Netherlands S.S. Co., have all along been arguing that heavy cranes are not yet needed in the Antilles, since the ships there have at their disposal all sorts of implements, as in contrast to European harbours where restorations and replacements of the lifting machinery are being made.

The interests of transit handling and local traffic are partly contradictory. When there are, as in Cristobal, ships carrying freight solely for local use and others with transit cargo, then it is quite easy to divide the harbour into two parts, each fitted according to its special requirements. In Curacao, however, the ships have mostly a mixed cargo and we therefore had to find a satisfactory compromise in the scheme. The length of the pier and quay has been stipulated at 1,000-ft., whereby it was taken into account that the ships calling at the port are rarely longer than 500-ft. Along the pier, four large boats could berth close

New Harbours of Aruba and Curacao—continued



Site of front wall, 63 ton block submerging.

to one another. In the compromise, we relinquished our original plan to enable transport from ship to ship straight across the pier. We kept in mind that, according to experts, the most economic way of transhipment in Curacao was generally by means of lighters.

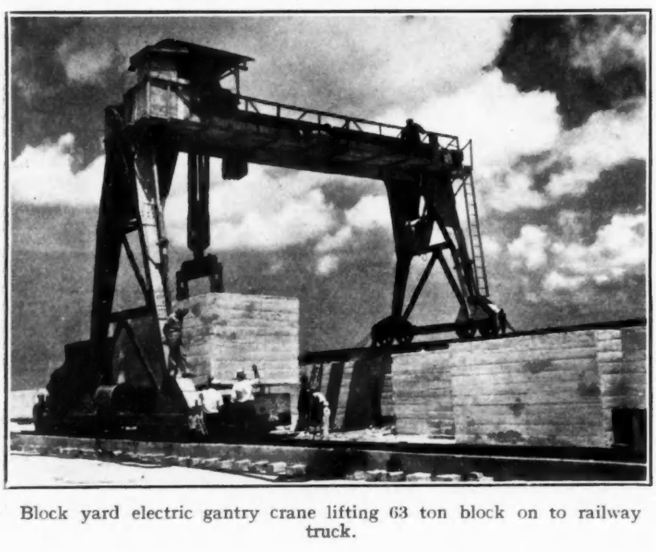
The goods destined for Curacao are to go by the shortest possible route along the pier as well as the quay: from the ship over the quay platform through a fairly small shed, where the customs are stationed, to lorries parked along the platform. Goods which are not collected within a certain time limit being taken to large warehouses which are let to private persons. Transport on the quays, most of which are allocated to lorries, is carried out by means of trucks and trolleys, etc.

Not only is it necessary to allow ample space for storage, but also to have sufficient warehouse space in the immediate surroundings. So for loading, a quay of 300 m. length was planned, along which the customs' sheds would be built. Transport proceeds to loading areas behind the sheds, which lie about 1 m. lower than the floor of the shed, so that the cleared goods can easily be placed on the lorries.

Where desired the goods can be dispatched direct to the private warehouses. On the quays themselves, therefore, there would be no lorries or other private vehicles, and everything would have to be transported by means of trucks and trolleys from the quay to the lorries waiting in front of the platform.

Another quay—included in the plan—in the direct vicinity of the shed will be 100 m. long and 4 m. wide for schooners, lighters, etc.

These are all to be seen in Fig. 5. From this plan it will be noticed that all the quays are built in the direction of the wind, and also that the total length of the quays in execution at present is 900 m., which leaves room for extension. The width of the basins between the quays is 100 m. From Fig. 1, it can be seen that this width is 70 m. in Aruba. This difference is due to the existing situation in Aruba, owing to which it was impossible to build the pier longer than 200 m., that is to say, for one ship along each side. There is at Aruba, therefore, no need for space to pass a third ship between two berthed ones.



Block yard electric gantry crane lifting 63 ton block on to railway truck.

When deciding on the situation and scope of the scheme, we kept in mind that the road traffic around Schottegat is very busy indeed and that it is therefore necessary to reorganize it somewhat before it reaches the network of routes. The building of an entirely new road, cutting the 4 k.m. stretch of the winding and busy Schottegat road, offers many advantages, about which we shall not go into detail here. In order to avoid difficulties with regard to the drainage of the soil to the east of the harbour, this road has been planned as a dam through the Schottegat, but at such a distance from the coast as to form a separate lake in the interior of sufficient size to make a satisfactory æsthetic whole. This lake would provide room for the too soft dredging materials.

The Harbour Commission eventually chose the larger scheme and was later seconded by the Government and Chambers of the Netherlands Antilles, for the following reasons:—

(a) The Government would be master in its own house.
(b) Valuable sites would be obtained to cover a considerable part of the costs.
(c) The position on the east side of the Schottegat would be more favourable from a nautical point of view, where the vessels can be moored against the wind and dirt and oil would be dislodged.
(d) The investment of a large amount of money in quays along St. Annabay was not considered justifiable. (A point which Mr. van Heemskerck stressed several times).
(e) The scheme of the Government would bring with it considerable improvement in traffic, the costs of which would be included in the harbour plan.

CONSTRUCTION OF THE QUAYS.

This problem in Curacao is entirely different to that in Aruba, since Curacao has no satisfactory sand of its own for concrete. A concrete wall here would therefore be more expensive than in Aruba.

Since steel sheet piling was obtainable at early delivery dates, we decided, although basing our invitations to tender upon walls made of concrete blocks, to leave an alternative for the tenderers to suggest other constructions. When considering the quotations, it was noted that two of the tenderers had made a considerable effort. At the request of N. V. Pletterij Nederhorst, Ir. B. H. Tellegen at the Hague had drawn up plans which attracted attention. For the building of a solid wall, this firm offered the lowest price, and some forms of construction on open caissons were only slightly more expensive, and they were studied carefully. We were, however, obliged to give preference to the lowest offer which came from the other tenderer, the Netherlands Harbour Works Co., Ltd., of Amsterdam, with an alternative project in cellular sheet piled construction, using flat " Senelle " sheet piling.

As far as I have been able to find out, this system has not yet been used in the Netherlands, but has been used extensively by the French, who applied and developed this steel saving method for retaining walls of 10 m. or more in height. The Americans have a similar form of sheet piling in " Lakawana ". Although several publications appeared abroad after the war, many practical questions remained unanswered, and I did not think, after full consideration, that this system was advisable unless those that had followed it up, not only in theory but also in practice, could give completely satisfactory information. After consultation with us, the Netherlands Harbour Works Co., Ltd., invited the French engineer, Mr. F. Beau, Chief Engineer of the French Public Works Department, who is an expert in the laboratory as well as in practice, to visit Curacao. Discussions and study with Mr. Beau confirmed our previous feeling that the project needed some improvements and he verified, what was even more important, that we should not hesitate to use Senelle, provided the construction was sound. Accordingly, J. C. Dudok, engineer in the Department of Public Works, went into the matter, and in the article, an account by him is set out wherein he considers in detail

New Harbours of Aruba and Curacao—*continued*

the principles and calculation of this type of construction. It will perhaps be sufficient here to add the following:—

Particular care for protection against corrosion was required for that part of the quay construction both between wind and water and above water. It will be seen that a system—the Cathodic—was chosen which was only effective under water or in moist soil. The steel sheet piling above water was therefore to be covered with a concrete coping, the lower edge of which lies

Ship alongside old wharf, Aruba, superstructure oil and cable trench, fender preparation in progress.

at 0.50 above Curacao Datum. The part of the steel piles above water level plays no part in the stability of the construction. The concrete coping must not transfer a vertical pressure to the sheet piling in view of the slenderness of the piles and the type of construction. This coping construction is combined with the bollard foundations, which are placed in the middle of the cells. Thus, a straight quay is built on a bent sheet steel curtain. We considered a quay wall consisting merely of a number of curved bays, as is sometimes applied in France, but found it was impracticable for Curacao.

It will, no doubt, provoke the question: why did we not adhere to the traditional construction of Holland, especially since we had had such favourable experience with the concrete wall in Aruba? There were three reasons for our decision: in the first place, it was known that the quality of the concrete in a wall at Curacao would be inferior to that in Aruba; the quality of stone-chips and sand being poorer, as previously mentioned. In the second place, the time factor was of great importance. The construction of quay walls would take many months more than the building of cells and interfere with co-ordinating the timing between the execution of the dredging and building of the quay. All the dredged materials needed for the filling at the back of the wall would temporarily have to be dumped elsewhere.

And thirdly, the last but not least side of the problem, was the financial question. The Senelle wall itself was cheaper than the concrete wall, and filling up behind the block wall would increase the cost of that type of construction so much that the steel sheet piling was finally decided upon.

Correspondence

To the Editor of *The Dock and Harbour Authority.*

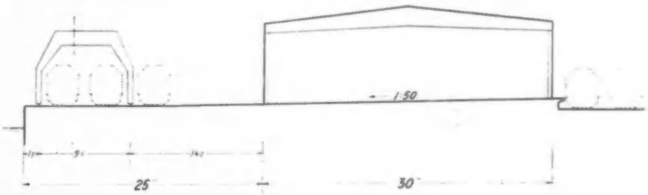
Dear Sir,

QUAY LAY-OUT AND THE PLACING OF SHEDS IN A GENERAL CARGO HARBOUR

The article by Chief Engineer, Mr. Herman Jansson in " The Dock and Harbour Authority " (No. 351, January, 1950), is a very interesting contribution to the study of quays for general cargo. One must agree essentially with his views, adjusting however, the conclusions gained theoretically to local conditions, for each port and each part of a port is a peculiar problem in itself.

There has been a continuous increase in the dimensions one has to give the widths of quays, but I suppose it will often prove impossible to reach the theoretically desirable widths—right up to 131 m—without complete re-construction, the expenses of which would be prohibitive.

In Oslo it has not been considered convenient to exceed 25 m. area in front of the sheds, in which area usually three railway tracks are laid. The cranes are constructed as full-portal cranes extended over two railway tracks. The distance between the crane rails is 9½ m. and the outer rail is laid 1½ m. inwards from the edge of the quay. These arrangements are shown in the accompanying sketch.



To facilitate the handling of traffic in Oslo, the railway tracks are " flatted " (or set in the quay) so that they can be used by both railway cars and motor vehicles.

The need to utilise the valuable shed and quay spaces to the greatest extent possible, makes is necessary to remove goods from them quickly to warehouses in regions of less value, and the development of motor transport has been a great help in speeding up this work.

A width of 30 m. has been adopted for the sheds, which are usually of one floor only, without inside columns. Somewhat broader sheds might be desirable, but it appears that the traffic can be handled satisfactorily, and a width of 60 m. seems actually not necessary for our conditions. It is contemplated constructing the new sheds with the floor sloping to quay level in front, at 1 : 50, with a loading ramp at the rear of the shed. It does not seem necessary, as suggested by Mr. Jansson, to reduce the slope to 1 : 125 or 1 : 150 owing to unbraked trucks.

Instead of loading ramps along the full gable length, newly-planned sheds will be provided with doors sufficiently large for the passage of mobile cranes and vehicles. However, motor transport is also to have access to the loading ramps.

In one case a warehouse building—40 m. wide—will be placed behind a row of sheds, where there is already an 11-storey warehouse for general and bonded stores. A private enterprise is also planning a new warehouse to be blasted in the hill alongside the harbour.

Where conditions do not permit normal sheds of adequate width and where space is required for the purpose of examination for Custom dues, waiting and dining rooms, etc., multi-storey buildings are also erected on the quays. With regard to loading balconies, a width of 4 m. may be desirable, but it is not yet considered worth while sacrificing space to that extent.

Direct driving with motor cars and trucks up to second floor might also be desirable, but such a ramp needs considerable space, and it will not often prove convenient.

As to the possibility of loading and unloading of ships with their own winches and deck cranes, there has so far been in Oslo very little interest in this way of working, even with new ships especially well equipped for this purpose.

Correspondence—continued

Mr. Jansson points out the need of comparative practical tests in order to prove whether trucks and tractor trains can replace quay cranes, and I suppose this proposal will be supported from all quarters. In considering his suggestion that a fork truck with a transporting distance of 100 m., has a capacity equal to a modern cargo quay crane, and costs no more than a fraction of the crane, a closer investigation would be justified. At least, however, it seems possible to reduce the number of cranes on a quay if sufficient equipment of the above-mentioned kind is at hand. When a quay section is fully occupied with ships and when it may be required to load and unload from all hatches, it seems reasonable not to leave the ship's own loading tackle idle. In such cases, cooperation by the deck cranes on ships with trucks and tractor trains would relieve the crane service. When the number of quay cranes is not based on maximum requirements, the overall operating time for the cranes would be more even, more effective and —as a result—more economic. Such a combination—I believe—would be better than exclusively horizontal transport from ship side.

It is indeed praiseworthy of Mr. Jansson to put up this question for discussion, and I hope "The Dock and Harbour Authority" will be enabled to pursue this matter by the publication of experiences from different ports and preferably actual tests.

Yours sincerely,
E. HOLST.

Chief Engineer,
Oslo Harbour Board,
Norway.

Cathodic Protection of Steelwork

Experimental Installation at the Port of Long Beach

In our issue of June, 1949, we published an article describing the Port of Long Beach, California, in which the proposals for cathodic protection of the steelwork of the wharves were briefly referred to by the author. As the subject is of considerable interest, a number of our readers have requested further details of the installations, and the following is a summary of some further information we have received from Mr. R. R. Shoemaker, the Chief Harbour Engineer to the Port of Long Beach.

It appears that, as a result of preliminary experiments, definite schemes have now been evolved and that the first units of cathodic protection of steel piles are about to be installed.

A great deal of experimental work was done in an attempt to arrive at the most efficient form of installation. Two general types of cathodic protection will be installed initially, one using a steel anode, with a rectifier for converting alternating current to direct current, as the energy source, and the other type using galvanic anodes (see Figures 1 and 2, showing the lay-out of the installations at Pier A, Berths 3 to 7). The effective protection of either type of installation is about equal, though details of local conditions may eventually result in the selection of one of these types of installation exclusively. Initial costs of the rectifier system are expected to exceed those of the galvanic anode system, with a reversal of this relationship for operation and maintenance costs.

It was found that with the steel anode in combination with a rectifier, the connections of the electric cable at the anodes have a tendency to dissipate long before the anode itself has been dissipated, and the resultant corrosion of the cable makes economical use of the steel anode difficult. Tests indicate, however, that by making a multiple grill work of scrap steel rail, and bonding the stranded cable lead at numerous locations on the anode, this problem may be overcome. Each bond should be well coated with a high dielectric coating to prevent electrolysis at the joints. With the steel anode constructed in such a manner that current dissipation over the entire surface of the anode is more uniform and with electrolysis of the electric cable and the cable bonds prevented, it is expected that little trouble will develop.

Magnesium anodes acting as a galvanic anode provide satisfactory protection against corrosion; however, what is the economical size of anode, and what the replacement charges, other than material costs, will be over a long period of time, has not been determined. Some difficulty may be expected in attaining satisfactory current distribution, due to the geometric layout of the steel piles to be protected. Electrical connections to the anode do not seem to be such a problem as with the steel anode and rectifier energy source.

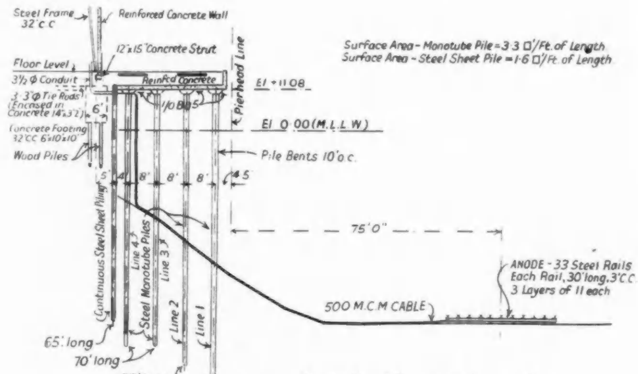


Fig. 1. Steel Anode with rectifier.

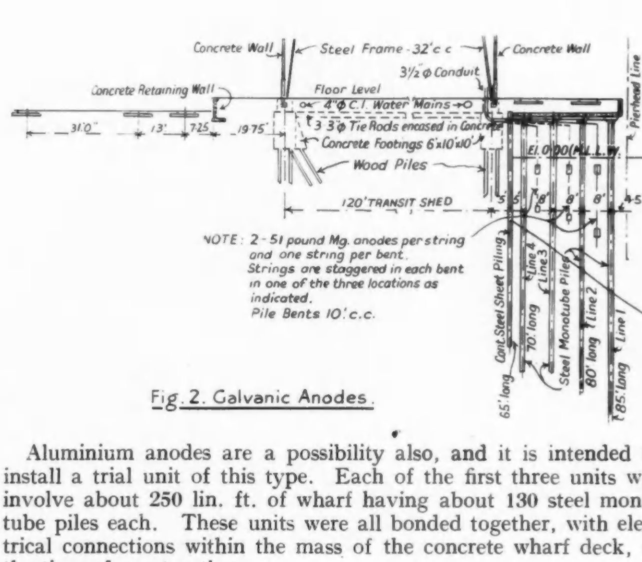


Fig. 2. Galvanic Anodes.

Aluminium anodes are a possibility also, and it is intended to install a trial unit of this type. Each of the first three units will involve about 250 lin. ft. of wharf having about 130 steel monotube piles each. These units were all bonded together, with electrical connections within the mass of the concrete wharf deck, at the time of construction.

For anti-corrosion protection of the steel piling above the mean tide level, some type of coating seems to be imperative, because this portion of the steel piles is subject to intense oxidation and possible potential change. This condition makes initial polarisation from a cathodic protection installation almost impossible in that particular area. Some of the recently-developed vinyl coatings are good dielectrics and have excellent ability to adhere to the steel surface. The abrasion to which such a coating is subjected is very minor and presents no problem. It is felt that a satisfactory protective coating has not yet been found and it is intended to experiment on a number of types.

DUTCH PORTS AND INLAND SHIPPING.

Figures just published in Holland show that inland shipping traffic in 1948 was appreciably higher than in 1947, but still a long way below the pre-war level. During the year, approximately 24,000 vessels arrived from Belgium, Germany, France and Switzerland, compared with 15,000 in 1947 and 50,000 in 1938.

A further milestone has been passed in the repair of war damage to port installations with the restoration of the 25,000-ton Hendrik dry dock in Amsterdam and the 46,000-ton floating lock at the Wilton Fijenoord dockyard at Schiedam.

Coast Erosion

An Enquiry into Causes and Remedies

By R. R. MINIKIN.

(Continued from page 25)

THE INFLUENCE OF LARGE STONE JETTIES

The longer and wider one's experience of maritime matters the more does one appreciate the importance of eddy currents. The smaller eddies of the beach are provoked by obstructions not only those direct and obvious barriers to an alongshore current but by the friction between the moving water and the almost still water contained between two groynes and the water line. We have already pointed out that the eddies caused by a high groyne extremity throws the gyrating water particles round the vertical axis seawards. Because these eddies do not always show on the surface it must not be taken for granted that they do not exist. They are strongest on the bottom layers of water and the top layers of water ride over them. Tne mobile material which may have been brought close to the weather side of tne groyne on coming into the influence of the outward eddy is whisked seaward again until such time as it drops out of the transporting current, maybe to rest there until some more powerful impulse sets it travelling again. It will be appreciated that even strong tidal currents will not be able to add sea bed material to a sloping beach, although they may push or roll it along a contour until wave action forces it shoreward.

Then we have two sets of forces, the strong dynamic but intermittent impulses of wave action and the direct continuous one of tidal, or eddy, current. Here it must not be forgotten that the wave impulse on the bottom is oscillatory, there is a forward acceleration as well as a backward and between the two a short rest period. Assuming the forward impulse in the direction of travel is normally greater than the rearward, the progress will be definitely ahead in small increments. Thus, if tne tidal current is in the direction of the seas there will be assistance to the forward travel but if the tidal current is directly opposed to it the travel will be reduced or negatived depending upon the relative strengths and influence of the waves and current at the given depth of sea bed. On an indented coastline and even on a straight one, the ebb and flood currents seldom run in directly contrary directions, in fact, for some period of time, the direction of flow may even coincide; again one may even take a direction normal to the other, as occurs near Dungeness where the flood currents for a short while strike due south. Thus it will be appreciated that the tidal currents do not always compensate each other. These apparent vagaries of the tidal stream are caused by the morphological features of the coastline, the sea bed contours, and the broad mechanism of the tidal phenomena of adjacent amphidromic centres.

Now it is reasonable to assume that what happens on the larger scale, in broad outline, is likely to happen on the smaller scale. That the assumption is tenable is evidenced by the increasing confidence in reduced model experiments on hydraulic systems. It is not the quantitative degree of similarity we are concerned with, but the behaviour.

On a free beach subjected to the fluctuations of natural sea forces there will be variations of the mobile material in response to the resultant of the forces imposed, for example, if it tends to act away from the locality, laterally or frontally, there will be erosion, on the other hand if it acts towards the locality there will be accretion. But all waves travel towards a shore line. The whole of their energy is broadly beneficent: they urge all mobile material shorewards; otherwise, all the grains, pebbles, and cobbles, of the transportable drift would be swallowed up in the depths. There would not be that diminishing size of grading of material over the littoral platform or indeed over the continental shelf. It is not the reluctance of the materials of the sea bed to conform to gravitational laws, they are just as eager to do so as solids in the dry, but sea action hinders their escape. If this limiting process did not operate by means of currents and wave impulse then the morphological features of land masses would be a continuous universal erosion causing a recession of the high water line everywhere.

All this sums up to the fact that the works of man on a shore line must not interfere too abruptly with the mechanism of water behaviour under elemental conditions. In practical parlance, this means one must encourage the natural tendencies to promote accretion to the degree only that the intensity of the accretion does not absorb the whole or the greater part of the natural supply to the weather side at the expense of the side to the lee. Also that the means adopted to achieve this end should be so designed to offer the least possible resistance to the natural processes of beach building, and the existing regime of the local coastal currents. From what has been said above of the forward growth of a natural untramelled beach, it is obvious that placing a barrier across the upper beach to pound up the material is not the only way to cause accretion, nor yet is it the more durable way.

Fig. 52. Hythe, damaged groyne.

Resuming the examination of the Hythe beach, there is a groyne which has been lengthened by about 50 feet. This lower end has been damaged and several strakes of planking are missing, thus virtually lowering the height of this part of the groyne (Fig. 52). The effect of this appears to be a flatter but broader beach with the increase of shingle seaward of the high step in the planking. The beach to the lee of the groyne, landwards of the high step, is not so favourable, the eddies swirling about the point having depleted the shingle locally. Over a length of about 1,500 yards, the beach shows the same characteristics: 1½-in. to 2-in. shingle at the crests, 1-in. to 1½-in. on the average over the bay slopes, and smaller shingle about the lee of the groynes. The last groyne of the series is the huge concrete Twiss groyne (Fig. 50). There is little doubt about the substantial appearance of this groyne, yet one cannot avoid feeling that the high and not very useful mound of shingle heaped up on the weather side could be more usefully employed to the lee, which looks more like the wall of a harbour entrance than a beach protecting construction. There is not the slightest doubt that it was, and is, successful in accumulating drift shingle, but in a manner which is at variance with coast protection. The great difference in height of the beach on the two sides is a constant threat to the stability of the sea wall, and the high mound tends to provoke a heaping up of the gale seas at high water springs to the west in the corner where the mound contacts the sea wall. The photograph shows that the lee water line is 100 feet landward of the water line to the west side of the groyne and that the lee beach is generally 20 feet below the beach to the weather side. Note the sand line in the foreground.

The Seabrooke beach, east of the Twiss groyne, shows a very marked change of profile and behaviour to the Hythe beach, as

Coast Erosion—continued

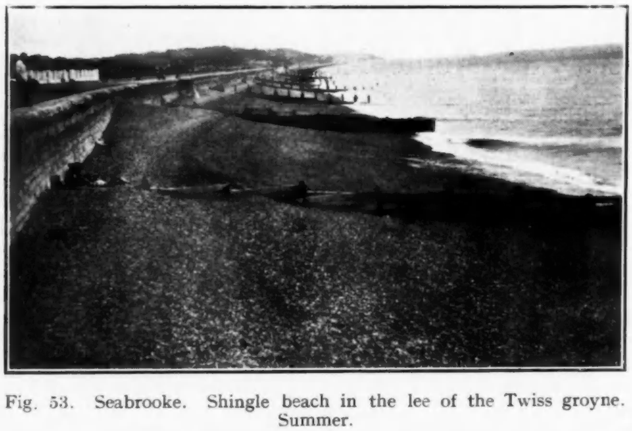


Fig. 53. Seabrooke. Shingle beach in the lee of the Twiss groyne. Summer.

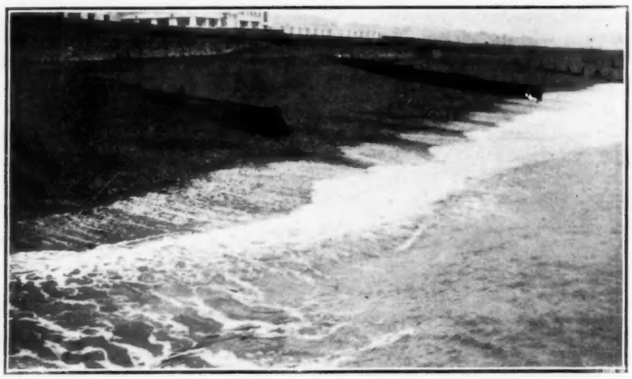


Fig. 54. Seabrooke. Note ridge formation of shingle beach just above the sand line. Winter

can be remarked from Figs. 53 and 54. Compare these with Figs. 33 and 51. It is at once seen that the height of shingle at the sea wall is considerably less in the former than the latter, actually 10 feet to 12 feet lower, the beach profile is flatter, and the groynes not so heavily stepped. Note the mounds of shingle in the weather left hand corners and the high water line of spring tides, which contacts all the wall in the groyne bays, excepting small triangles enclosing the mounds. The first two groynes are the only ones of the series so favoured, and owe it to the slight spill of shingle over the Twiss groyne. The rest of the beach for over 2,000 yards, having about 33 groynes in poor repair, has a bare appearance and but meagre quantities of small shingle lie in the groyne bays. Since the Twiss groyne was constructed this shore line has been the source of much anxiety. High groynes were tried and proved dismal failures; the beach was swept bare of shingle, and the sea wall which had only been built about 10 years earlier (1890) was partially demolished. Since 1900 it has been found more effective to erect flatter groynes, as those shown in the photograph. Generally the beach is in a depleted state, suffering a general debility by reason of the interference of the Twiss groyne.

It is also to be noted from the illustration that there is a second lower beach crest favouring the prevailing lee due to south-east seas, the diminishing wavelets of which are to be seen in the middle right approaching the shore. Note, too, a feature which the author has found to be associated with all shingle-beaches showing recent depletion, the central bareness and lower contours of a slight valley at the middle of the groyne bay allowing the surge to throw an isolated and forward tongue beyond the general line of the surge tip. In these slight dips one finds sand and small shingle pebbles with only a sparse, here and there, distribution of medium sized shingle. For the greater part, the groynes are aligned normal to the wall, but in the middle of the length a number are aligned at 10 degrees to the west of the normal. In the distance of the photograph, at the end of the gentle sweep of the bay, lies Sandgate, which faces due south.

In the course of observations of shingle beaches suffering from depletion, the author began to note that in the lee of high groynes there was an appearance, near the junction of shingle and sand, of a tendency for the shingle to form undulating ridges, like a series of uniform waves. This was first noted on the beach at Winchelsea, which is very flat and covered with timber wave-breakers that disrupted the uniformity of the phenomenon. However, after a S.W. storm on the Sandgate front, when the beach was severely denuded, the phenomenon showed up again in the lee of the new timber groyne at Seapoint immediately in front of the cafe and bathing station. A sketch made on the site at the time is shown in Fig. 55, from which it will be noted that the ridges, where most of the larger pebbles were clustered on the crests, formed valleys between them one foot deep. Attempts to make tests on the behaviour of the pebbles did not yield anything new. There was a rising tide and the wintry weather put an end to the investigation. On visiting the spot early the following day to catch a falling tide, it was found that the ridges had disappeared and the shingle was thinned out. But exactly a year later in this same spot on a falling tide, after a severe storm which had holed the old sea wall in the lee of the groyne and washed out the foundations of the cafe and Memorial Gardens, the depleted beach showed a pattern of uniformly spaced shingle ridges shown in the photograph Fig. 56.

The next occasion of noting this phenomenon was at Herne Bay, in the lee of the stone groyne east of the Clock Tower, but again the rising tide gave no chance of investigation. Several other similar faint indications have been witnessed, and only latterly was a good measurable example noted. Following a strong S.W. sea and on a falling tide, the photograph and sketch Figs. 57 and 58 respectively were taken in the lee of the Twiss groyne, Hythe. Obtaining a collection of burnt brick pebbles of varying sizes from 2 to 4 inches diameter, tests of the transporting behaviour of the wave surge were made. The arrows in Fig. 58 show the directions in which the majority of the pebbles were impelled.

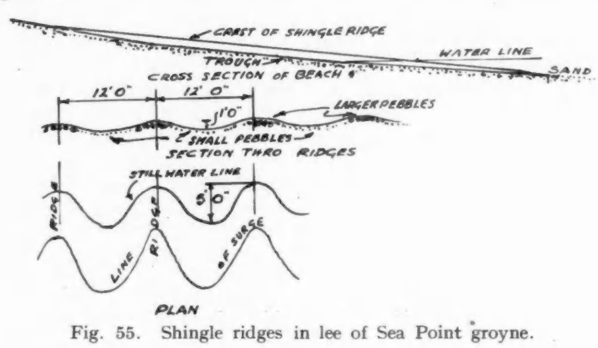


Fig. 55. Shingle ridges in lee of Sea Point groyne.

Fig. 56. Undulating shingle ridge on Sandgate beach. Jan. 1949

Coast Erosion—continued

It was then seen that the action could be described as follows: a pebble placed in the water at A was trundled forward up the beach slantwise to the right and eventually came to rest somewhere along the full line marked ridge, whereas a pebble placed at B was washed forward and in fitful movements made a circular swing to the left and in the drawdown of the returning surge was lost to view. Thus it was assumed that it had passed out of the influence of the wave action in the small valley. When pebbles were placed at C, they also disappeared, and with a falling tide laying the beach bare were not found again.

Usually on a flat beach the separate tongues of surge fan out over one another, showing no preference for any one spot, but here, as will be seen more clearly in the photograph Fig. 54, the surge tongues are separate and each seems to be confined to one shallow valley between the ridges of shingle.

In the second valley from the Twiss groyne, the action was less definite than in the first; most pebbles came to rest on the ridge line to the right, a smaller number on the ridge to the left, and the rest was drawn down by the retreating surge in the trough of the valley. In this manner, what was virtually happening was a creeping of the left ridge to the right hand, increasing the width of the first valley and swinging the ridge line slantwise across the beach. In the third valley, a similar but fainter action was apparent. This action was judged to be the probable cause of the over-lapping of the ridge curves higher up the beach, just discernible in Figs. 54 and 57, but quite clear and pronounced on the actual beach. As the tide fell, the shingle thinned out and the ridges merged into the sand, and across the beach the shingle was spread out in a currant-cake pattern. At the time of the observations, the wave front was almost parallel to the water line, a moderate S.S.W. wind and waves about 2 feet high. Compare the Figs. 50 and 53 with Figs. 54 and 57. The wind and wave front for the former approach from the east at an angle of about 30 degrees to the shore line.

In the valleys further to the right of the first groyne there was

Fig. 57. Seabrooke. Shingle ridge formation on lower beach. Winter.

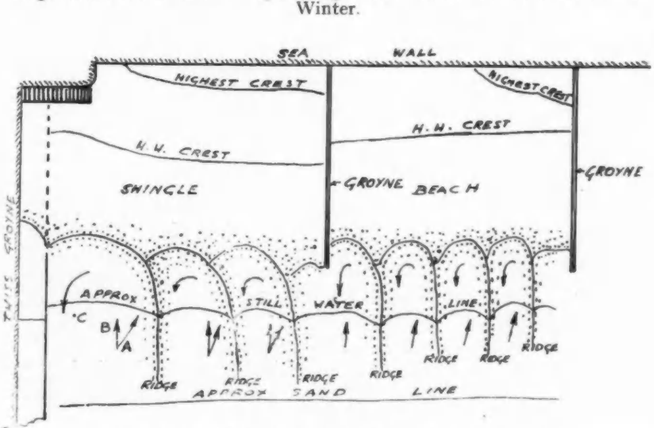


Fig. 58. Shingle ridges in lee of Twiss groyne.

Fig. 59. High new timber groyne directly west of Sandgate Castle.

Fig. 60. Storm damage to Sandgate Castle due to depletion of the beach shingle.

less lateral bias and a more pronounced drawdown. After some scores of tests in the manner described above, the author came tentatively to the conclusion that this seemingly trivial phenomenon showed much that was worthy of further investigation, for here nature was demonstrating the process of accretion and depletion at the same time on a scale that could be easily measured. There appeared every reason to conclude that it was in the sum a depletion process.

This portion of the coast line from Seabrooke to the Riviera, Folkestone, has widely fluctuating beach profiles. In the stretch from Sandgate Castle for 1,000 yards west the sea wall and beach in the last 75 years have suffered heavy damage—in fact, every winter seems to bring a load of expensive repairs, excepting, surprisingly enough, during the war years, when the groynes fell into bad repair. During 1938-40 the beach on this front was in good heart and maintained a level of $1\frac{1}{2}$-in. to 2-in. shingle about 6 feet below the top of the sea wall alongside the Hythe Road, and slightly lower contours on the front from Sea Point to Sandgate Castle. During the winter (1945-6) gales a portion of the sea wall and roadway near Sea Point bathing station was destroyed and the beach shingle considerably lowered. A new sea wall of substantial design, with a sheet pile toe curtain, was erected for a length of about 200 yards. The old random coursed rubble wall with concrete backing and parapet, from Sea Point to the Castle, remained as it was, and the whole of the beach was re-groyned with timbers of sturdy scantling already described. These groynes were erected to full height, that is, the top strakes of planking were a few inches below the top of the sea-wall, about 10 feet above the beach surface at the Parade, and 7 feet above at Sea Point (Fig. 59).

There were several local reasons why these groynes should not have been constructed so high, apart from the defects already adumbrated: (a) with the exception of the new length of sea wall, the remainder was of poor construction and the aprons were already exposed to within a few inches of the base. (b) The south-west

Coast Erosion—*continued*

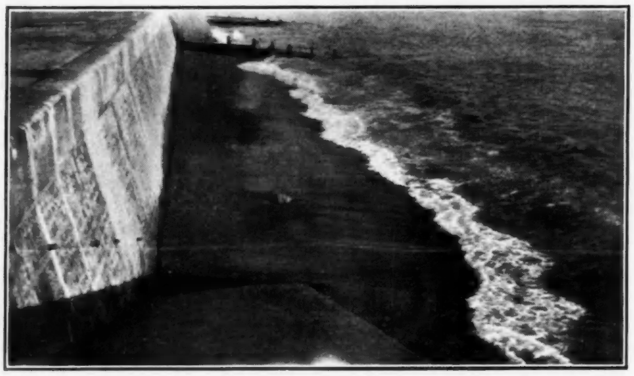


Fig. 61. New sea wall at Sandgate alongside of the Hythe Road.

gales strike the shore line at an angle of 45 degrees, and as the groynes are normal to the sea-wall, it is obvious that each groyne immediately to the west of another will partially blind the lee corner of the groyne bay, but the north-east corner will bear the brunt of the seas, which, striking the high groyne at an angle of 45 degrees, will cause a strong and tumultous swirling of the waters in a violent anti-clockwise eddy, provoking a powerful under-current to the lower contours of the north-west lee corner. This will deplete the beach rapidly and tend to undermine the already shallowly founded sea-wall. In parenthesis, the author can vouch for the strong outward under-current at this place by actual body contact in more moderate south-west seas. (c) The height and spacing of the new groynes could not have been fixed upon reliable data of the rate of littoral supply of the locality. The whole series from the first one driven at the east end of the Parade were erected in a twelve-month, to the full height. It will therefore be appreciated that even in the most favourable circumstances it could not be expected that these groynes could accrete a sufficiency of material to build up a uniform beach. One or two did accrete rapidly, to the weather side, particularly number one, which held a height of 10 feet of shingle over the lee height. The consequence was that in the following winter gales, the sea wall to the immediate lee was demolished and the foundations to the old Castle were undermined. Since these groynes have been erected, the beach has suffered great depletion generally and the damage to the old sea walls has been severe, as the photos (Figs. 59 and 60) show.

Since the above was written, a mid-autumn south-west gale has again struck the coast and an account of it is not without interest. At 11 o'clock on an October morning the sea was relatively calm, when a sudden south-west wind of 45 m.p.h. (Beaufort scale 8) sprang up, and within an hour heavy breakers were rolling over the strand and pounding the sea walls. The beach was, at the time, in a depleted condition generally, with the exception of one or two abnormal accretions to the weather side of the Parade groynes. There had been little or no gain of shingle during the summer months, so that the beach profiles were on the average 6 to 7 feet below the normal of the last 20 years. When the gale arose, it wanted but one hour to high water springs, with the result that there was an exceptionally high tide, and the breaking water and shingle were thrown high into the air. The surge and sea within the plunge line took on a brownish hue with the presence of quantities of suspended sand and shingle.

Fig. 62. New sea wall in course of construction at Sea Point, inset a breach in the old wall.

On the turn of the tide it was noted that the sea walls had suffered serious damage in several places, and where the breaches had occurred large holes were scoured out in the backfill of the walls. With one exception, all the breaches were due to the failure of the foundations. To obtain a true perspective of the occurrence, the following points must be noted. Along this 800 yards of sea frontage, the sea walls are mainly private responsibilities and suffer from the defects inherent in divided interest and lack of co-ordinated planning. For the greater part, they are founded on the shingle of the beach at too high a level; they are constructed of unsuitable materials and in a form inadequate for sea defence where the tidal waters contact the wall on a shingle beach. Several of the privately owned groynes (Fig. 60) were in very bad repair. Before the storm arose, there had been a heavy rainfall in the district, the land was saturated and naturally the water table was high; the consequence was that the old walls were statically in a weak condition of stability. There was another important factor: the new high timber groynes erected in front of the corporate property had accentuated the see-saw conditions of the beach and had retained to the weather (west) side (Fig. 59) large quantities of shingle to the detriment of the lee strand.

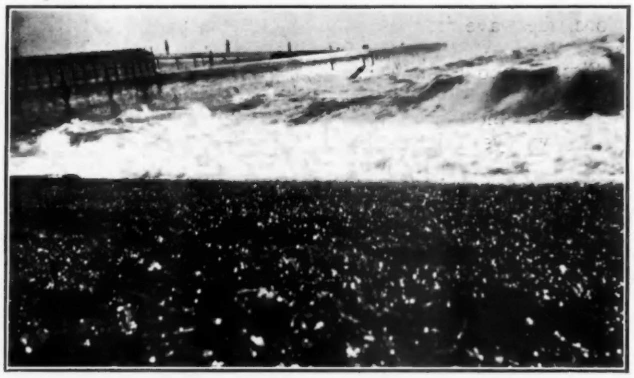


Fig. 63. Dover. Storm waves attacking the beach at West Bay.

Now the point is, what can be usefully learnt from these details? When the war finished (1945), the beach was about 4 feet below pre-war normal height and the Hythe Road old sea wall was breached east of Sea Point in the winter 1945-6. A new length of sturdy wall was constructed (Fig. 61) and the corporate property frontage was protected by new high groynes, which, in their first winter, accreted large mounds of shingle to the weather side but lowered the beach to the lee of the groynes considerably. However, a late winter storm (1947) breached the old wall in the lee of the most easterly groyne and also fractured the foundations of Sandgate Castle. The following winter, conditions were worsened and the old wall fronting Sea Point Café was breached in three places; again this was in the lee of a high groyne. Yet again, the following winter, the heavy damage detailed above occurred, mostly in the near lee of the high groynes. Thus it would appear, and the author has no doubt regarding it, that the depletion of the beach, the primary cause of the foundations failure, has been accelerated by the unnecessary height of the groynes. The new length of wall in the course of construction fronting the Sea Point has a curved face (Fig. 62), with a toe curtain wall of steel sheet piling. It will be noted from the photograph that the new wall is being constructed to the front of the old coursed rubble apron of the original wall, which is in effect 12 feet seaward of the old wall face. The small inset shows one of the breaches in the wall now covered by the new curved concrete wall.

Coast Erosion—*continued*

Fig. 64. Dover. The curling over and meeting of a partially reflected wave in the corner.

COMPLEXITIES OF BEACH STABILITY

An open shingle beach devoid of obstructions, such as groynes or sea walls, can withstand terrific bombardments of heavy seas without damage, but, even in favourable accretion conditions, any solid obstruction against which the waves may break, or change their kinetic energy into potential energy by increasing the height of the water mass without absorption, is almost certain to cause depletion of mobile material. The potential energy is destroyed on the gravitational fall back of the water into the sea. This is less destructive when the fall is vertical; when it is deflected in a horizontal plane and gives rise to a swirling current, it is the more destructive.

The photographs (Figs. 63 and 64) of Dover west bay were taken in the New Year gale of 1949. A heavy S.W. sea was running and the waves were approaching the shore at a speed such that there was little diminution of the waves amplitude. They broke on the beach plunge line from 12 to 15 feet high in a depth of water probably not more than 10 feet deep. To the west of the Dover pier, some 300 feet (Fig. 63), an approaching wave is shown in the right forefront. It was about 15 feet high trough to crest, towering above the broken surf; the breakwater in the left background gives a good idea of the proportions. The photographer was standing about 20 feet above the surge line. At the time, the tide was below half level; the stonework freeboard of the pier was about 35 feet above still water, and the ridge of the station steelwork about 70 feet above. When the break took place, the foam and green water rose to a height of 20 to 25 feet. In this cloud of water (Fig. 65), one could see quite plainly large cobbles of shingle, like currants in a cake, thrown up with it, a few isolated ones being projected clear of the foam. Despite this severe stirring up of the beach, the general profile of the open part was unaffected, but near the wall there was a visible lateral dispersion. It should be borne in mind that the wave fronts tended to sweep into the corner formed by the pier with the beach, and that mobile shingle would therefore be swept into it. It no doubt was, but towards the corner there were other factors which countered this tendency. The waves, as they approached the corner, were subjected to the partial reflection of the waves immediately preceding them (this can be observed in the Fig. 64). The added turmoil in the corner thus swept the mobile shingle to the side and depleted a quantity of that already there against the wall. The tongue of white surge to the left of the photos show the trench alongside the wall, and the bend of the surge line in the forefront of Fig. 64 shows the resulting heightened hump of the beach. *(To be continued)*

Fig. 65. Dover. The break of a storm wave on the beach.

The Port of Bombay

Excerpts from Administration Report, 1948-49

The year closed with a surplus of Rs. 63.93 lakhs on the General Account and a deficit of Rs. 2.76 lakhs on the Pilotage Account giving a net surplus of Rs. 61.17 lakhs on the working of the port as a whole. This surplus, however, is entirely due to the receipt of abnormal demurrage fees, amounting to over Rs. 126 lakhs but for which the year's working would have shown a deficit.

The unprecedented increase in the volume of imports specially of food-grains, diversion of ships to Bombay owing to the loss of Karachi, shortage of transport facilities, congestion of railway traffic at up-country stations, inadequacy of storage accommodation in the docks and the city and the unresponsive attitude of Labour all contributed to the greatest congestion that has ever occurred in the history of the port. Various measures were taken by the Trustees and Government to put matters right. Fork Lifts for quicker handling and higher stacking of cargo were purchased and orders placed for the purchase of 4 electric cranes for use at Ballard Pier; Buffer sites were provided at Wadala to take up the overflow of cargo; certain concessions which militated against prompt clearance of cargo by merchants were withdrawn; a Port Clearance Committee and a Port Working Committee were constituted to watch the day-to-day position of cargo clearance, and a new section (64-A) was inserted in the B.P.T. Act, empowering the Trustees to sell, by auction, uncleared cargo if not removed within a stipulated period irrespective of whether charges thereon were paid or not. These and other measures have yielded satisfactory results and the docks congestion has eased to a considerable extent.

MODERNISATION PLANS

Plans have been drawn up for a long-term development and modernisation of the port and include the following:—

(1) Construction of New Ferry berths and removal of traffic from the present site; (2) construction of a new entrance lock to Prince's and Victoria Docks; (3) construction of a new Dry Dock; (4) improvements to road communications and (5) lengthening of the Ballard Pier.

The construction of an Uncleared Goods Warehouse at the Alexandra Dock, and of three Transit Sheds at the Prince's and Victoria Docks, was commenced during the year. One of the sheds, it is expected, will be ready for use by the end of this year, another by March and the third by the middle of next year. The Uncleared Goods Warehouse should be completed by the end of next year. Plans and estimates for the development of Frere Basin for lighterage traffic were also approved during the year. The scheme provides for the construction of six open sheds, boundary wall, gates, electric installations, railway sidings, etc., and when completed it will provide an enclosed area for handling seaborne merchandise ordinarily stored in the Wet Docks.

Another important event of the year is the decasualisation of the dock labour. The previous system known as the Toliwalla system under which labourers were engaged as and when required, through the agency of contractors, had given rise to many malpractices. It was therefore abolished from April, 1948, a large number of the labourers previously in the employ of the Toliwallas being taken over by the Trustees as their own employees. This ensured for the dockers a minimum guaranteed wage, security of employment and the usual service benefits admissible to Port Trust employees. The Trustees also introduced an Incentive Bonus Scheme to encourage labour to increase its earnings by a greater output.

Pneumatic Locks

By Ing. T. TILLINGER.
(Member of the Technical Council of the Ministry of Communications, Warsaw, Poland)*

The problem of surmounting high lifts on inland waterways is of very great importance. At the present time it appears to be particularly important in view of the proposed construction of the Odra-Danube canal, where there is a difference in level of nearly 80 metres caused by three falls. It is therefore very opportune that the programme of the Seventeenth International Congress of Navigation at Lisbon should consider the problem of high lifts.

At the session of the Central Section of the Association of Navigation specially devoted to this problem and held in Berlin in 1925, Professor de Thierry came to the conclusion that barge lifts can be divided into two groups :

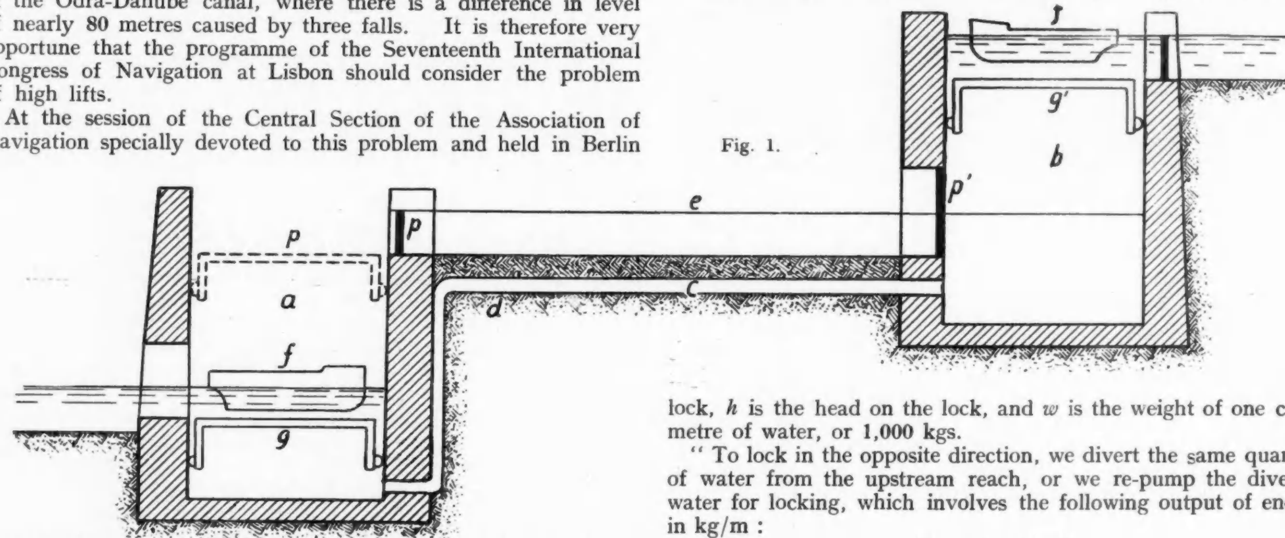


Fig. 1.

(1) Inclined planes.
(2) Vertical lifts.

The last group of which include :

(a) Hydraulic lifts.
(b) Floating lifts.
(c) Funicular lifts.

Meanwhile, in the *Course of Inland Navigation,* Fourth Part, *Canals,* 1931 Edition, Professor Bonnet mentions yet a fourth group on page 335, the pneumatic locks, of which he gives the following description on page 369 :

" We have yet another novel solution in the so-called pneumatic lock devised by M. Tillinger.

" Let us assume that at the ends of a reach of a canal *e* (Fig. 1) there are two air chambers *a* and *b*, joined together by a conduit *c* provided with a stop valve *d*, and in the two chambers there are two identical locks *g*, g^1 representing a pneumatic piston. If a vessel enters the lock at f^1 and the valve *d* is opened, the piston g^1 will descend and because of the air under pressure transmitted through the conduit, the piston *g* will rise. Both will arrive together at the level of the intermediate reach. The sluice p^1 can then be opened, so that the craft can be passed into the reach *e*, and so to the piston *g* after the sluice *p* has been opened; if a load is placed on this piston it will descend and at the same time the piston g^1 will rise owing to the air pressure in the conduit. The manœuvre will be similar for a rising craft. The consumption of water apart from waste is reduced to that necessary to ensure the necessary overload for lifting.

" The operating principles of pneumatic locks can be divided into two groups :

(1) Locks operating on the bell system.
(2) Locks with entirely pneumatic operation.

" The Dulton and de Moravek locks are typical of the first type. It is easy to understand their operation by referring to Fig. 2; on introducing a certain quantity of water into the chamber e^1, and upon opening the valve *c* in the conduit joining A and B, we shall pass air from one bell to the other, and thus the bell B will descend and the bell A will rise.

" The disadvantage of this system is that the depth of water required is very great.

" The weight G of the prism of water necessary to lock vessels by an ordinary lock is given by :

$$G = w.b.c.h.$$

where *b* and *c* are the width and length respectively of the lock, *h* is the head on the lock, and *w* is the weight of one cubic metre of water, or 1,000 kgs.

" To lock in the opposite direction, we divert the same quantity of water from the upstream reach, or we re-pump the diverted water for locking, which involves the following output of energy in kg/m :

$$E = w.b.c.h^2 + F$$

where F is the energy expended to overcome frictional resistance. If we replace water by air, the elevation of the prism of air necessary to refill the upper lock chamber will amount only to the energy necessary to overcome frictional resistance.

" This is the basic idea of coupled pneumatic locks, and applying particularly to the Austrian Schanzer system of 1907, and the Tillinger system of 1910. In the Schanzer system, in each of two coupled lock chambers there is a platform of rectangular form in plan filled with water (Fig. 3). The space between the platform and the lock wall is made airtight with suitable packing, but the construction and details of this have not been described. It is obvious that in order to avoid the escape of compressed air, this packing must be tightly pressed against the wall, and this will cause considerable friction.

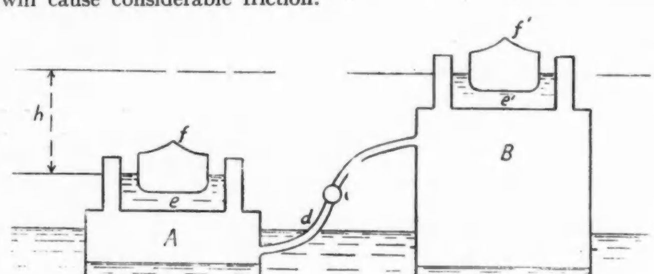


Fig. 2.

" In the Tillinger system, the problem was tackled in another way. The mobile platform is built in the form of a barge upside down, as shown in Fig. 4 ; above this platform the lock chamber is filled with water, the necessary sealing being obtained at such a depth, where the hydrostatic pressure of the water is greater than that of the compressed air under the weight of the platform. With a head of water of 2.50 metres on the platform, the weight of the latter being about 0.5 ton per square metre, the force compressing the air will rise to about 3 tons per square

*A paper read before the International Navigation Congress, 1949—Section I, Inland Navigation, Question 2—Means of dealing with large differences of head (translated from the French). Reprints of this paper can be obtained on application to the Permanent Association of Navigation Congresses, Brussels, Belgium.

Pneumatic Locks—continued

metre, that is to say the air will be under a pressure of 1.3 atmospheres.

"The packing should therefore be arranged at a greater depth than 3 metres.

"The patentee of this system has stated :

"This pneumatic lock is distinguished by the fact that the water over the platform which provides hermetic seal for the lock chamber operates in such a manner that air and water pressures balance one another."

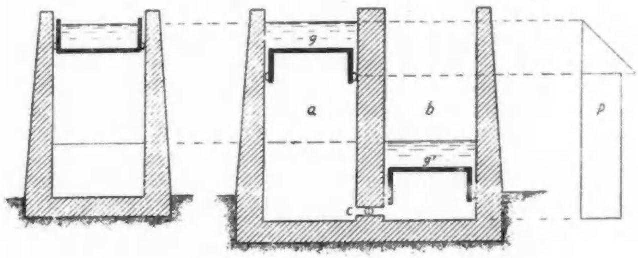


Fig. 3.

The solution of the problem of sealing between the mobile platform and the lock wall does not appear to present insurmountable difficulties. However, it ought to be adjustable, that is to say that during the movement of the platform, the pressure on the packing should not be so great that it causes excessive friction. On the other hand, when the platform is stationary, the pressure should be increased in order to avoid escape of water.

It is evident that we can apply different systems here more or less successfully, and the following details are taken from an article in the Polish technical journal *Czasopismo Techniczne*, published in Lwow.

Just below the platform *a* (Fig. 4), is fixed an oblong cushion *b*, which is filled with water and comprises a timber or rubber *c* and a leather or rubber cushion *d-d*, fixed to the packing *c*, and also to the mobile platform *a*. The valve *g* allows water to pass from the columns *h* and h^1 of different height, thereby producing a change of pressure in the rubber cushion and thus a similar change of pressure between the packing and the lock wall. When the platform is stationary, the cushion is joined to the column h^1 and a perfect seal is obtained.

When the platform is moving, the cushion is joined to the column *h*, and we reduce the pressure as much as possible in order not to impede the movement of the platform.

For example, if we wish to obtain a pressure of 20 kgs. per square metre on the packing, which appears to be sufficient to prevent heavy escape of the water, then with the packing 20 centimetres high it will be sufficient to have the height of the water in the lower column *h* about 10 cms. above the level of the water over the platform. If we join the cushion *b* to the column *h*, with a height of 2 metres, we shall obtain a pressure of 200 kgs. per square metre, which will be quite sufficient to provide hermetic seal. It is evident that such seal should be provided not only along the lateral lock walls, but also on the upstream and downstream walls. When we consider high-lift locks, the upstream sluices should be made in such a manner that when they are closed they are in the same plane as the surface of the wall. Rolling or lifting sluices can be employed.

For a cushion 60 cms. by 10 cms., and assuming a coefficient of friction between timber and iron of 0.30, the frictional resistance will be 0.30 x 20 x 140, or 840 kgs. It will be necessary to have at least a cubic metre of surcharge to surmount this resistance. In addition, some force is required to push the air from one lock chamber into the other. This force will depend upon the speed of the air and the shape of the conduit through which it passes. It will not be very great.

For a conduit with a cross sectional area of 4 square metres, and the downward velocity of the platform being 0.05 metre per second—with similar dimensions for the cushion—we obtain an air speed of 7.5 metres per second. One of the advantages of a pneumatic lock is that the walls below the mobile platform are not subjected to water pressure which increases with depth, but to a constant air pressure corresponding more or less to a water head of 3 metres. Thus the lock walls of such a lock can be less massive than those of a conventional lock. Although the operation of a pneumatic lock may give rise to some difficulties, it appears that these should be surmountable.

The following facts should be taken into consideration :

(1) Maintenance of the seal to avoid loss of air is not an easy task. However, suitable covering of the lock walls and accurate adjustment of the packing should do much to help in this respect.

(2) Compressibility of air means that in its passage from one lock chamber to the other it will not act in the same manner as an ideal liquid, which does not change its volume under pressure. Under load, the platform *g* (Fig. 3), will descend a certain distance in compressing the air below it, before the platform g^1 starts to move. The platform *g* will reach its lowest position on the bottom of the lock before the platform g^1 arrives at the required height, and therefore it will stop at some distance x^1 from the necessary operating height. This can be obviated by opening a valve in the bottom of the platform and diverting a certain quantity of water in order to reduce the weight and thus facilitate raising of the platform. If we call *y* the height of the water level diverted in this manner, it will suffice to stop the platform when the water level in the rising lock is 2 *y* units lower than the water level of the upstream reach, thus ensuring continuous operation of the lock.

We proceed in the reverse manner for movement in the opposite direction. Each time we divert from each chamber a head of water *y*, but it is evident that *y* will only be a small proportion of the total head on the lock.

Maintenance of the lock chamber in a horizontal position is a problem encountered in every form of barge lift. This can be achieved by means of rollers, as shown in Fig. 5 (a) or by means of a system of chains (b) applied to funicular lifts. Another idea is to introduce double packings (c) and (c^1), or the three systems can be applied simultaneously.

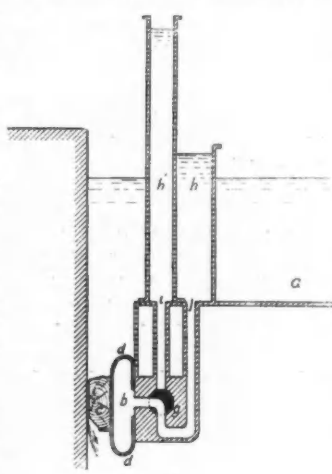


Fig. 4.

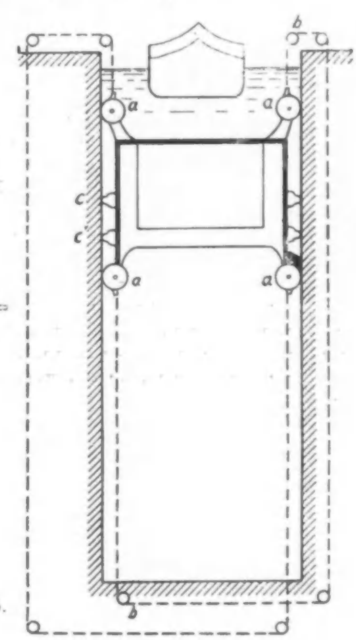


Fig. 5.

From our observations we can conclude that the pneumatic lock system is attractive. But the examination of its advantages and disadvantages can perhaps be realised only on an accurate model. This applies particularly to the sealing system.

(Continued on page 63)

Permanent International Association of Navigation Congresses

Report of the British National Committee up to June, 1950

Though the Permanent Association has been in existence for many years, there was not, until recently, any specific sub-organisation in this country. The Council of the Institution of Civil Engineers to remedy this situation decided in October, 1947, to set up a British National Committee. This Committee was formed with the full approval of the Ministry of Transport and at present consists of twelve members. The aims and objects laid down for the Committee were identical in all essentials with those formulated in the Constitution to which the approval of members is sought at the Annual General Meeting.

The Council permitted the Institution to undertake the administrative and secretarial work of the newly-formed British National Committee and at the request of the Secretary-General in Brussels, the work of accepting payment of subscriptions from members in this country was undertaken also. These subscriptions are forwarded to Brussels in bulk twice a year and individual members are thus saved the trouble of applying for currency permits, etc.

The British National Committee took active steps to ensure adequate British participation in the 1949 Congress at Lisbon and by reason of its endeavours no less than thirteen Papers from this country were contributed through the Committee. Assistance was also given to the Secretary-General in publicising the Congress arrangements and also in connection with the translation of certain of the Papers.

The British Section was well represented at the Congress and more than a dozen members from the country attended, took their full share in all the Proceedings, and contributed to the Discussions on the various technical subjects.

The Committee has also, from time to time, assisted the Secretary-General in the nomination of members to certain of the Committees of the Association.

The Committee has also made representations that consideration should be given to holding the next Congress in this country subject to satisfactory assurance that adequate financial and other support would be forthcoming.

The present National Committee has existed for about 2½ years and they consider that the time has arrived when it is necessary to set the British Section and the British National Committee on a more formal basis. The Constitution which is presented for the approval of the Annual General Meeting is the outcome of these considerations.

The first Annual General Meeting of the British Section will be held on Thursday, 22nd June, 1950, at 4.30 p.m. at the Institution of Civil Engineers, and the Committee will be grateful if members will assist in publicising the activities of the British Section of the Association and in encouraging those who may be interested, to join the Association so that this country may be adequately represented in the affairs of the International Association and at the Congresses.

ORGANIZATION AND OBJECTS OF THE BRITISH SECTION AND OF THE BRITISH NATIONAL COMMITTEE

1.—Definitions and Objects.

The British Section of the Permanent International Association of Navigation Congresses shall comprise all members of all categories of the Association normally resident or established in the United Kingdom.

The British Section shall be administered by the British National Committee which shall be elected in accordance with paragraph 2 hereunder.

The object of the British Section and of the British National Committee is to create and foster interest in the International Association and to co-ordinate the participation, by members resident or established in the United Kingdom, in all the activities of the Association, and particularly in the Congresses.

2.—Composition of the British National Committee.

The British National Committee shall be composed of:

(i) Six ex-officio members, consisting of the four United Kingdom representatives nominated by the Ministry of Transport to serve on the Permanent Commission of the Association; the Harbour Engineer of the Ministry of Transport; and one member to be appointed by the British Transport Commission, and

(ii) nine ordinary members elected as follows:

(a) At the first Annual General Meeting to be held in June, 1950, all the nine members shall be elected from a balloting list (containing not less than twelve names) prepared by the existing British National Committee.

(b) At each subsequent Annual General Meeting the vacancies as defined in (c) hereafter) shall be filled by persons elected at the meeting from a balloting list (containing at least three more names than the number of vacancies being balloted for) prepared by the then British National Committee.

(c) **Period of Office.** Three out of the nine ordinary members elected at the first Annual General Meeting shall retire at the end of each subsequent year, the members to retire at the end of the first and second years being selected by lot. Retiring members shall not be eligible for re-election until after an interval of at least one year. At each Annual General Meeting after the first the vacancies caused by retirement or otherwise shall be filled in accordance with Clause 2 (ii) (b). No Member having had three consecutive years service shall be eligible for re-election until after an interval of at least one year.

(iii) The Chairman shall be appointed by the members of the British National Committee.

3.—Annual General Meeting.

The British National Committee shall call an Annual General Meeting for the purpose of presenting their annual report and for electing new members to the Committee and at least six weeks' notice of such meeting shall be given to members.

The Annual General Meeting shall be held in June of each year, the date being approved by the Chairman.

These meetings shall be held at the Institution of Civil Engineers and voting thereat shall be restricted to members of the British Section as defined in Clause 1 hereof. Corporation Members shall be entitled to be represented and to vote at the Annual General Meeting, by nominees, the number of which they would be entitled to send to the Congresses under the Regulations of the International Association in force at the time.

Members unable to attend the Annual General Meeting may record their votes by post on a ballot form which will be issued with the notice convening the meeting. Completed forms shall be returned to the Secretary at least seven days before the date of the meeting.

4.—Constitution.

The terms of this Constitution shall not be modified except by a majority vote of those present at an Annual General Meeting. In the case of an equality of votes the Chairman shall have a casting vote. Notice of any proposal to modify the constitution must be received by the Secretary in writing, at least a month before the appropriate Annual General Meeting and shall be supported by at least ten members of the British Section.

5.—Secretariat.

The secretarial work of the Committee shall be undertaken by the Institution of Civil Engineers, Great George Street, London.

SCOTTISH EAST COAST PORTS.

All railway-owned docks on the Scottish East Coast have now been placed under the administration of Grangemouth. Mr. James Newman, formerly traffic superintendent at Grangemouth, has been appointed Docks Manager, Scottish East Coast Ports, under the Docks and Inland Waterways Executive. The following ports will now be under his charge: Tayport, Methil, Burntisland, Alloa and Grangemouth.

Some Modern Cargo Handling Appliances

Review of Mechanical Equipment used in British Ports

By E. S. TOOTH.

(continued from page 14)

(2) MOBILE CRANES

The first article in this series dealt with modern mechanical equipment employed in the actual operations of loading and discharging ships. The need for maximum speed in that essential work, together with the increase in size and weight of both import and export packages have made it necessary for Dock and Harbour Authorities and Port Employers to find new methods of handling cargo whilst it is in transit to and from ship. In this sphere two machines of primary importance, the mobile crane and the fork lift truck, have been introduced in recent years—the former in greater numbers because the employment of fork lift trucks on port work has presented certain difficulties which have not yet been resolved.

Whether the port be a rail port—like Bristol, where in the Royal Edward and Avonmouth Docks all ships berths, transit sheds, warehouse granaries and cold stores are directly served by railway lines giving delivery to exchange sidings—or one where the majority of traffic passes into or out of the system by means of water and road conveyance, it has been found expedient to introduce mobile cranes in considerable numbers. There is, of course, no standard mobile crane, for as mentioned in the previous article, the type of package and the geography of the premises through which it has to pass, to a large extent control the kind of machine it is possible to use. This makes necessary the employment of a wide range of each kind of machine—and the mobile crane is no exception.

Although some mobile cranes are electric, being either battery or mains operated, most are petrol electric, diesel electric or direct diesel driven. Possibly because of the smaller fire risk, the majority of ports appear to prefer machines with diesel electric or straight diesel engines. As with quay cranes, capacities vary over a wide range, and there are mobile cranes with a maximum capacity of 10 cwts. and others which can lift 12½ tons. It is probably true to say that a "standard" light machine would have a capacity of about 2 tons; a standard "heavy," of about 5 tons. Jib lengths vary similarly—from a few feet to as much as 80 feet. The type of tyre, solid or pneumatic, is also of importance. Solid tyres sink into soft ground but are thought to be better on certain hard surfaces. Pneumatic tyres will cope with most surfaces but must be maintained at correct pressure. In some circumstances it is an advantage to have the crane mounted on a caterpillar track.

Another factor of extreme importance is outreach. It is not unusual that in order to pick up its maximum load, the jib of a mobile crane must luff up so far that the crane hook plumbs only three or four feet clear of the chassis. This is not confined to British machines, nor is it as unreasonable as it may appear at first sight, for there is no reason why the opportunity should not be provided to make such a lift when the heavy package concerned is small enough. Outreach, however, is of extreme importance in port work and is one of the problems with which manufacturers have had to wrestle.

At this point it will be well worth while to note that besides the difference in construction, there is a fundamental difference between operating a mobile crane and operating a standard quay crane. The quay crane, if not permanently fixed to the premises, is bolted to its rail track when in use and usually is rated with a fixed lifting capacity at whatever radius it is being worked. As long, therefore, as the maximum load is not exceeded, as far as the driver is concerned, its operation is comparatively simple.

The mobile crane is a different proposition. There are three main factors which are of extreme importance in connection with its use:—(1) it must be stable (2) it must be manoeuvrable and (3) account must always be taken of the fact that its safe working load varies according to the angle of the jib.

These factors involve a high degree of efficiency by the driver, who, after he has manoeuvred the crane into a required position on a possibly congested quay, must always be alert not to overload it. Once a standard quay crane picks up a package within its stipulated capacity the driver is no longer concerned with the safe working load, provided the load is held plumb. If a mobile crane picks up a package within its maximum lifting capacity, the driver must always be sure not to luff out so far that he is overloading the crane. If he does so, even should the machinery and structure of the crane stand up to a strain for which they were not designed, there is the grave danger that the crane will tip over. Tyres of of uneven pressure, and the swinging of a load during the slewing operation also make for instability. Cases have been known, too, where the driver, so familiar with the performance of his crane that he has deemed it unnecessary to watch his safe-load indicator, has omitted to take account of the camber on the road on which he is working, with the result that the crane has been overloaded and has tipped over. On level surface, such an accident would not have occurred.

Fig. 1.

The importance of the efficiency of the driver of any mechanical appliance used in port work cannot be over-emphasised—particularly in "piecework" ports. The men are there to earn their living and the aim of the gangs as well as that of the management is to attain the maximum speed consistent with safety. The "atmosphere" of the job has a psychological effect and an effcient driver does much to produce a good atmosphere. Sometimes, however, he can make an error of judgment which takes a certain amount of retrieving. An incident at a certain port will illustrate this point.

Some Modern Cargo Handling Appliances—continued

The gang was delivering to lorry sacks of cocoa from a first-floor loophole by means of mobile crane. Owing to the port practice, the driver was stowing his lorry alone and this was naturally the bottle-neck of the operation. There was always a set of bags hanging near his vehicle. He was certainly making an effort to keep pace with the piecework gang, but as he became hotter he became less enthusiastic. At last, the slick mobile crane driver brought a set of bags round too far. It hung over the driver's bent body and as he straightened his back, knocked off his cap, baring his bald head. The lorry driver stopped work, and, chin out, was preparing to tell

Fig. 2.

the crane driver what he thought of him, when a voice from the loophole above saved the situation. A round-faced man with a beaming smile shouted down " Hi mate! Where d'you get them 'air cuts with an 'ole in the middle? " The lorry driver had to laugh. The error of judgment was retrieved and work was resumed.

It has been stated that the quay crane must be speedy and reliable. The mobile crane must in addition be stable and manoeuvrable. Work cannot always be done on flat surfaces under ideal conditions and mobile crane manufacturers are incorporating in the design of their machines any factor which makes for stability, manœuvrability and simplicity of operation.

In the achievement of stability, the counter balance weight is a primary consideration. Two points which manufacturers bear in mind in this connection are (1) that all counter-balance weight is in effect " wasted work " and (2) that the tail radius of the crane must be kept to a minimum. The aim, therefore, is to incorporate the lightest possible counter weight consistent with safety. Tyre pressures are also a factor affecting stability and, as a safeguard against sudden deflation, some cranes have wheels fitted with metal flanges which prevent the crane sinking on to a wheel rim in the event of an escape of air from one of the tyres. Some heavy-duty cranes are fitted with jacks or outriggers which are screwed down into a position alongside each wheel, thus enabling the crane to work on a fixed base. These jacks, however, need only be employed when heaviest lifts are being taken.

Manoeuvrability is obtained by various methods. One way frequently employed is to construct the crane so that the whole superstructure, including the driver's cab, slews with the jib round the full circle. The crane, once placed, can then reach out in all directions, with the driver always facing his work. Another method of obtaining manoeuvrability is by designing the whole crane—i.e., the chassis as well as the superstructure—to slew, usually by means of the castor action of one or other of the axles.

As far as simplicity of operation is concerned, some makers have attempted to make the working of the crane as safe as possible by fitting automatic cut-outs which operate to prevent over-loading. Some of these are effective only on the luffing operation but the ideal cut-out operates on the hoisting motion as well—for a crane can be overloaded in more than one way. It can attempt to pick up a lift outside its maximum capacity; it can also luff out to a dangerous radius after it has picked up a load at a " safe " radius. Moreover, if overloaded without serious result when the jib is fore and aft, upon slewing to an athwart position, the crane may be in great danger of tipping over. Automatic cut-outs, however, are not yet a standard feature. In most cases the driver has to watch a visual indicator as well as the load he is manipulating but it has been found possible with some types of crane to fit a warning bell which rings loudly if the safe radius for the load being lifted is exceeded.

In some quarters the opinion is held that petrol engines are simpler for starting but, as stated elsewhere, possibly because of smaller fire risk, most ports appear to prefer diesel driven machines. Electrically driven machines are, of course, easy to operate and economic to run but it is not always convenient to have extensive charging facilities for battery-driven machines and moreover the alternative mains-operated machines are often insufficiently " mobile."

The Ransomes and Rapier $3\frac{1}{2}$/5-ton super mobile crane (see Figure 1.) is an example of a crane which, in order to obtain the maximum manœuvrability, has its rear wheels—the steering and driving wheels—mounted on a castor which is pivoted to a king post in the tail of the crane. The pivotal attachment enables the castor wheels to accommodate themselves to uneven ground so that the crane is always supported on only three points—the two front wheels and the castor post. Hence the crane is always steady.

The castor can be turned by the steering wheel, through a right angle in either direction from the " right ahead " position. Thus the crane can be made to travel straight ahead, in a curve of any radius, or to rotate about the mid point of its front axle. In addition to this, an important feaure is that the whole superstructure can revolve on the chassis in a complete circle, enabling the crane to operate in confined spaces.

This crane, all the wheels of which have solid rubber tyres, is one of the types frequently used for handling exports. It has a cantilever jib, it can be rigged to lift either a maximum of $3\frac{1}{2}$ tons or 5 tons and its outreach is satisfactory. At its maximum radius of 17 ft. it can lift $1\frac{1}{4}$ tons at 55 ft. per minute; at its minimum radius of 7 ft., 5 tons at 25 ft. per minute. It is 11 ft. 9 in. long (excluding jib), 7 ft. 6 in. wide and the maximum drift under hook to ground is 20 ft. The crane is powered by either a diesel electric or petrol electric engine. It is of interest to note, by the way, that, without any additions, this machine is suitable for operating " hook-on " grabs.

The uses to which mobile cranes can be put are numerous. Goods landed on to the quay are usually taken into a transit shed or delivered direct to road or rail vehicle. Sometimes they go straight through the shed to an adjacent warehouse. In a number of ports much hand piling in shed has been superseded by piling by mobile crane. The first few tiers are sometimes put down by hand but subsequent sets of cargo are lifted on to the tiers already stowed and " put away " by hand. The height of the piles is only limited by the drift of the crane or the height of the shed.

The advantages gained by using the crane for high piling are greater speed, a saving of floor space and a saving of labour,

Some Modern Cargo Handling Appliances—continued

especially when the goods can be brought to the piling ground already made up in sets on, say, electric platform trucks or trailers. Bags of cocoa, sugar, palm kernels and other commodities are often piled 18 ft. to 20 ft. high by a gang using a 2-ton mobile crane, the men concerned being relieved of much arduous work.

Figure 2 illustrates a typical machine used for this and other important port work. It is the type " NM " Neal Rapid Diesel Driven Mobile Crane, having a capacity of 2 tons at 14 ft. radius, with any form of straight channel or lattice jib up to 35 ft. long. The standard jib is 25 ft. Its hoisting speed when rigged for 2 tons is 50 ft. per minute; when rigged for 1 ton, 100 ft. per minute. This crane has a full circle slewing motion, the entire superstructure, including the driver's cab, revolving on adjustable steel tapered rollers, bearing on a slewing ring with top and bottom opposed and bevelled roller paths. The makers claim a high degree of operational safety due to the patent safety hoist unit, the application of a self-actuating, multiple friction shoe device, giving positive control of the load at all times. As with other satisfactory machines, attention has been paid to outreach.

When goods (cocoa or palm kernels for example) are required for delivery, mobile cranes may again be employed, firstly at the pile and then, after the goods have been trucked to the vehicle, secondly to lift and place them for stowing in railway truck or lorry. This again is a quicker operation, naturally requiring a smaller gang than is necessary for a wholly manual job. Mobile cranes are also used to serve vault openings, and cranes fitted with long jibs are satisfactory for transferring goods from water conveyance to quay or vice versa. Long jib cranes will also serve warehouse loopholes and the upper floors of transit sheds.

With the destruction during the war of many port buildings, the use of warehouse sites and other open ground for storage purposes has became necessary in a number of British ports. A typical operation when such space is employed is upon bags of sugar or grain landed from ship or craft for stowing under steel housing units on open ground away from the waterside. Sets of bags are placed on electric platform trucks or alternatively on trailers and conveyed, sometimes long distances, to the stowage ground. Here they are lifted and piled in one operation by a mobile crane.

Port officials, faced with a new problem every day, are always being called upon to use ingenuity in their work. In some cases the ground may be too rough for the satisfactory passage of loaded vehicles and two and sometimes three long-jibbed mobile cranes have been employed to transfer goods from the roadside of the shed to the open ground further away from the dock water. The first crane is placed so that by luffing out to its maximum extent it will pick up a set. It then slews round 180°, placing the set under plumb of the second crane which performs the same operation. The third crane picks up the set, slews like the others and lands the goods on their storage ground. By this means goods can be piled a fair distance from the first point of handling on ground which would otherwise be difficult to use. No truckmen are employed; besides the pilers and men to build up the steel housing units, only mobile crane drivers are needed on the quay.

The delivery of goods stored in the open is often an extremely quick, simple and cheap operation, for both the mobile crane and the delivery conveyance can frequently be brought close enough to the pile for the delivery to be made direct. The gang need then only consist of the men on the pile and the crane driver.

No account of the use of mobile cranes would be complete without reference to the part they play in striking and shipping off exports. For some years, British export traffic has not only been great in volume but the variety of size, shape and weight of package has been larger than ever before experienced. In the work of unloading these packages from railway truck and lorry and subsequently, at the appropriate time, of tendering them at the ship's side, the mobile crane has became extremely important. Indeed, if the present volume of traffic is to be kept flowing freely through our ports, it is indispensable.

As has already been mentioned, there is particular need at the present period for machines to deal with heavy packages. Despite the scarcity of certain raw materials, British manufacturers have not been slow in meeting the demand for heavy duty mobile cranes and many types of machines with capacities ranging from 3 to 12 tons are being usefully employed.

The Coles 12½-tons mobile crane (Figure 3), made by Steels Engineering Products, Ltd., of Sunderland, is one of the types having jacks or outriggers so as to provide a fixed base for the crane when taking its heaviest lifts. Its outreach at minimum radius is small but with a standard jib of 30 ft. it has proved useful for handling loads up to 6 tons to and from barges at a radius of 20ft. 3 ins. It has reversible steering and the superstructure, which includes driver's cab, revolves through 360°. Electro magnetic brakes are fitted to the hoist, luffing and slewing motors and are automatically applied whenever a circuit is interrupted, whether by accident or intention. The maximum load with which this crane may travel is 8½ tons. The power unit is either a Ford V.8 or a Perkins P.4 diesel engine. The crane weighs 22 tons.

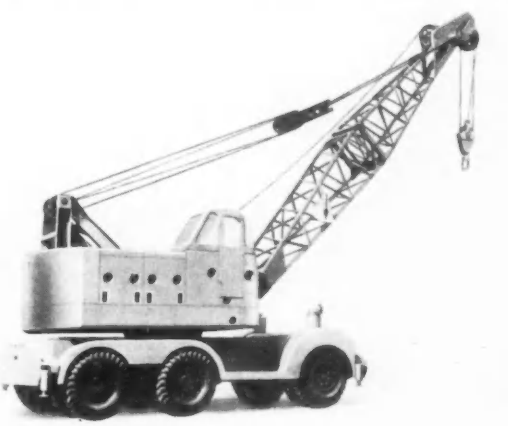


Fig. 3.

There is also in use a 20-ton mobile crane, made by the same firm. It is a diesel driven, lorry mounted machine and, with a standard jib, it can lift 20 tons at its minimum radius of 10 ft.; with the jib athwart the chassis, the outreach is 3 ft. 3 in. This, of course, is a fixed base duty. With free base, the maximum lift at minimum radius is 11½ tons. With the jib fully luffed-out, the safe working load is 5 tons fixed base and 3 tons free base. The turning radius is 30 ft.; unladen, the crane weighs 25½ tons.

Besides what might very broadly be called the conventional types, there are mobile cranes built for special purposes. One of these is the above mentioned 12½-ton crane fitted with an 80-ft. jib. At its minimum radius of 14 ft. this crane can lift up to 3½ tons, or 8 tons with outriggers in position. For general work with lifts of, say, not exceeding one ton, it can work at a radius of 32 ft. or, with outriggers fixed, at a radius of 60 ft.

Another machine for special duty is the luffing lift mobile crane. It has no slewing action but the jib luffs on the hydraulic principle. This machine can be used in low-pitched storage buildings where roof members and somtimes stanchions prevent the use of a mobile crane of the standard slewing type. Slewing is, of course, by steering and the absence of a jib slewing motion is also offset by the fact that the permanent fore and aft position of the jib enables the crane to travel with a load with complete safety. It is a fast travelling crane, having a maximum speed, laden, of 20 miles per hour.

The present important position of mobile cranes in port work is, like that of the quay crane, to some extent due to the late war. No doubt the need for the speedy turn round of ships would of itself have resulted in the introduction of more mobile cranes into the work of cargo handling, but the destruction of premises has necessitated their employment in larger numbers and with greater ingenuity. For one thing, enemy activity destroyed many existing purchases, particularly wall cranes, and created a need for machines to serve partly destroyed sheds and warehouses; for another, it

(Continued on page 63)

Concrete in Dock and Harbour Construction

A Review of Recent Developments

By ROLT HAMMOND, A.C.G.I., A.M.I.C.E.

Concrete is an extremely versatile material, and in its many different forms it has numerous applications in dock and harbour construction, ranging from massive quay walls and monoliths to prestressed concrete beams for roof trusses and similar structures.

In maritime works it is important to remember that concrete exposed to sea-water is liable to suffer from chemical attack on the cement; this results in the crystallisation of salts within the pores of the concrete, an effect which is particularly noticeable at positions just above water level where the alternate wetting and drying

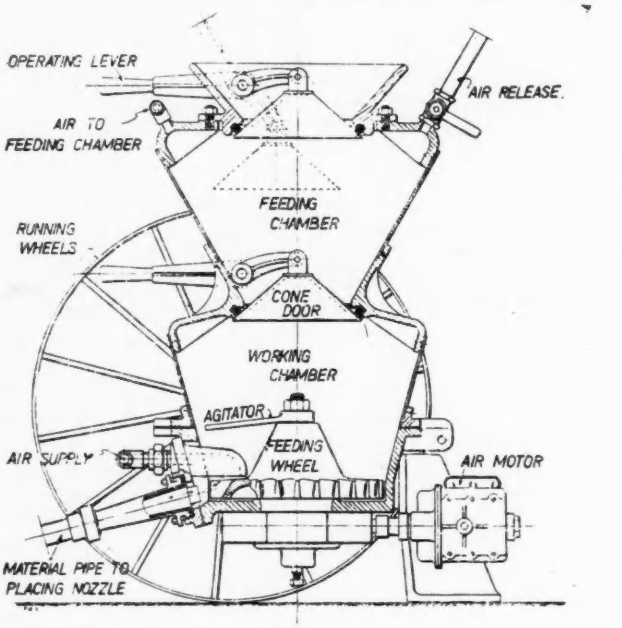


Fig. 1

of the concrete surface helps this process. Frost action, mechanical attrition and wave impact are all important contributory factors towards the breaking up of concrete in marine structures; in these respects reinforced concrete is more liable to attack than plain concrete, because spray and sea-water may penetrate as far as the reinforcing steel. The latter will then be corroded, followed by disruption and splitting of concrete.

Maintenance and repair of such structures are expensive items in the budget of the authority responsible for upkeep, and in many cases heavy damage may occur only a few years after construction of the works. The cement gun has become an excellent tool for such repairs, and during the war the author had ample opportunity of inspecting work done by this means in connection with the repair of bomb damage on a number of reinforced concrete members supporting a harbour railway station structure.

In this process a cement and sand mixture is impinged into position under an air pressure of between 40 and 50 lbs. per sq. in. The plant consists of an air compressor, a cement gun, and the necessary piping for conveying water, air and material and a placing nozzle. The air compressor should have a delivery of from 200 to 250 cub. ft. of air per minute at pressure of at least 80 lbs. per sq. in. Fig. 1 shows the apparatus, the feeding and working chambers of which are designed to withstand a pressure of 60 lbs. per sq. in. (The photographs on the next page show reconditioning with Gunite carried out at Consett Ironworks.)

As a matter of interest, the author had a slab of Gunite prepared measuring 6-in. sq. and being about ½-in. thick; the material was so dense that no impression could be made upon it even with a sharp knife. The process is admirable for building up damaged reinforced concrete or mass concrete structures, or for applying a protective layer of impermeable material to the face of such structures as an additional form of protection, thereby prolonging their useful life. Tests of Gunite slabs made of a 3 : 1 cement/sand mix have given a crushing strength of 3,700 lbs. per sq. in. at 7 days, as compared with 3,000 lbs. per sq. in. for concrete of the same age and of good average quality.

Tests of Concrete in Sea-Water

An interesting series of tests in connection with the deterioration of concrete in sea-water was carried out by the Sea Action Committee of the Institution of Civil Engineers in collaboration with the Building Research Station. Test specimens consisted of short reinforced concrete piles, 5-ft. long and 5-in. square in cross section, with steel reinforcing bars having a cover of 1 or 2 inches of concrete, made with various cements and with different mixes. These piles were partially immersed in sea-water and were arranged so as to be subjected to tidal action at Sheerness Dockyard and at Sekondi on the Gold Coast, thus providing a wide range of conditions from a tropical to a temperate climate. In addition, a further set of piles was partially immersed in tanks containing an artificial solution of three times normal sea-water concentration, arrangements being made to reproduce tidal action.

Cements included normal and rapid-hardening Portland cements, Portland blast-furnace cement and high-alumina cements, as well as pozzolanic cements in which trass, burnt clay, burnt shale and sand were substituted for part of the Portland cement. Rich, medium and lean concrete mixes were tested and the conclusions reached have been published from time to time in the reports of the Sea Action Committee. A cover over the steel reinforcement of 2-in. of concrete having one part of cement to 5 parts of aggregate has generally given good protection to the piles, but with this mix cracking occurred after an exposure of nine years. Excellent results were reported for the high alumina-cement concrete, except in the case of the lean 1 : 9 mix, where failure occurred quite early owing to high porosity of the concrete.

The curves in Fig. 2 show the crushing strengths of totally immersed specimens up to 10 years, the figures in brackets indicating the water/cement ratio in each case. These tests generally corroborated the qualitative observations made on the test piles referred to above. The 1 : 9 concrete, made from ordinary and rapid hardening Portland cements, suffered seriously from deterioration in a year or two; the 1 : 5 mixes, except in one case of ordinary Portland cement, also deteriorated steadily after about two years. The richer 1 : 2 2/5 mix showed only a slight deterioration in ten years. In the case of 1 : 9 high-alumina cement, the mixes were practically destroyed after about six years, whereas the richer 1 : 5 and 1 : 2 2/5 mixes were unaffected after ten years. Specimens from the richer mixes suffered no damage in concentrated sea-water, and strength was substantially similar to that of specimens in tap water.

Some extremely valuable and interesting tests have been carried out by Campus on concrete and mortar prisms immersed for 11 years in sea-water at Ostend,* this water containing a 1.5 per cent. solution of magnesium sulphate; for comparison, specimens were also immersed in tap water. In every case the behaviour of the various cements was similar to that observed in the British tests referred to above.

Conclusions Reached by Campus

The main conclusion reached by Campus was that when making concrete for maritime works, a rich and well-graded mix should be employed without excess of fine material to ensure dense and water-tight concrete—not less than about 760 lbs. of cement per cubic yard, equivalent to a 1 : 4 mix. Furthermore, he advocates careful placing of the concrete, the employment of steel shuttering, application of vibration to the concrete, and careful control of all concreting operations. An important point that he stresses is the

* *" Essais sur la resistance des mortiers et betons a l'eau de mer."* Tests on the resistance of mortars and cements to sea-water. University of Liége, Brussels, 1947.

Concrete in Dock and Harbour Construction—continued

need for paying particular attention to construction joints, because if these are poorly made they will allow moisture to penetrate and this may eventually lead to complete disruption of the work. This has happened to breakwaters.

The addition of new concrete to structures in sea-water between tidal levels is a matter demanding great care; new work should be applied in one coat, or both coats should be applied between the same tides. Where two-coat work is applied between separate tides there is a risk that a good bond will not be obtained owing to surface attack by the rising sea-water on the unmatured first coat, a point brought out in a recent paper by Lea & Davey.[1]

Recent Developments in Concrete Composition

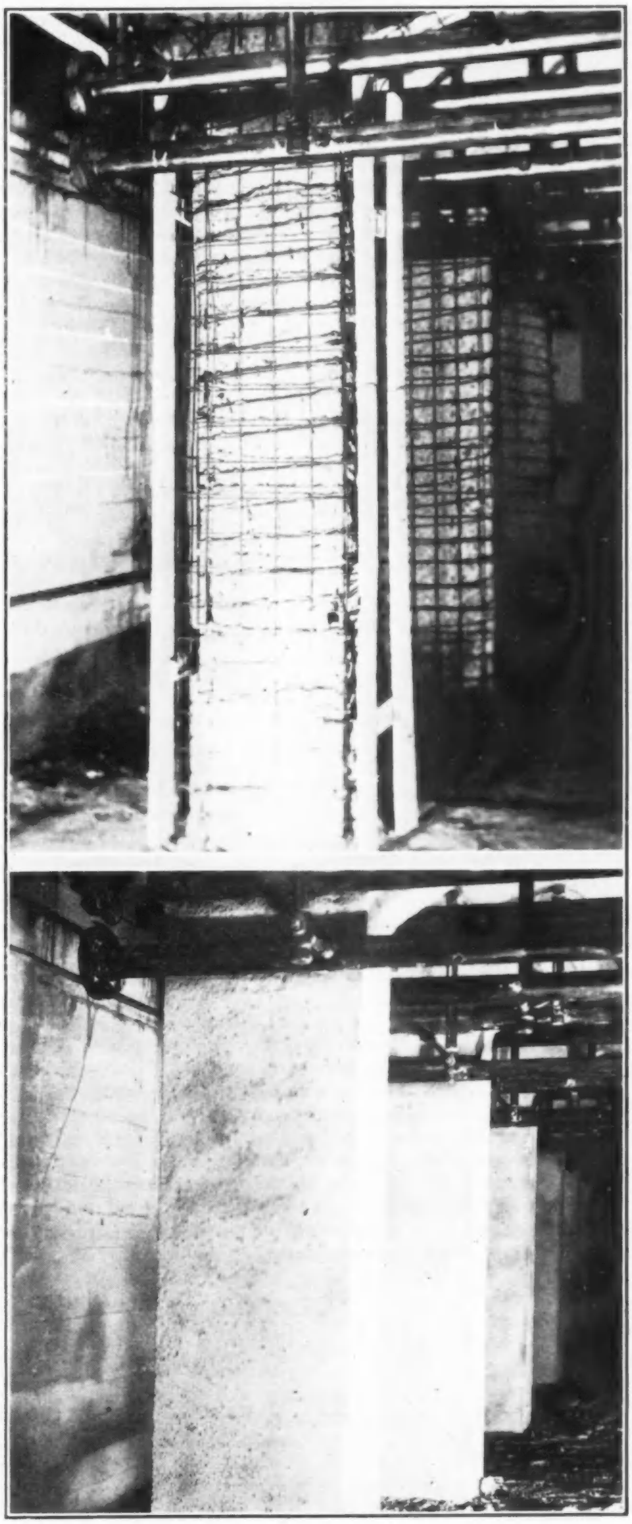
Much research work has been carried out on various means of increasing the durability of concrete exposed to attack by sea water. An investigation has been undertaken by Daniels into the effect on the properties of concrete of an addition of calcite, with special reference to its durability when exposed to sea action in tidal zones, and to resistance to attack by sulphuric acid. He states that practical results of tests prove that calcite mineralogically has a neutralising action on the free lime in the concrete. By adding calcite equal to 20 or 30 per cent. of the weight of the cement, he claims to have obtained a homogeneous mix of improved workability with less water than hitherto; calcite is said to have a neutralising and binding action on any humus present, and to increase the compressive strength of the concrete.

Further valuable work on the formulation of cements to resist attack by sea-water has been carried out by Gallo at the University of Pisa[2] and very favourable results have been obtained by substituting barium oxide for lime in cement. A mixture of tri-barium silicate 75, bi-barium silicate 7, and tri-barium aluminate 22 per cent. set in 20 minutes, successfully resisting the action of sulphate water. By mixing silica, alumina, oxide of iron, and barium carbonate and heating at 1,500 degrees for half-an-hour, the resultant product consists of tri-barium silicate 76, and teta-barium aluminate 24 per cent.; this began to set 40 minutes after mixing with water, the final set being obtained at 1 hour 50 minutes. This cement resisted the action of sea-water and did not tend to crumble in fresh water, owing to the presence of a thin protective coating of barium carbonate.

Vibrated Concrete

Much study has been devoted to vibrated concrete in recent years, and Smith[3] has pointed out that in the past workability and consistency of concrete was largely controlled by the slump test, but that to-day concrete having no slump can be efficiently placed and finished by vibrating machines. Lacey and Robb[4] have shown that the degree of compaction obtained by machine depends upon the length of time for which the vibratory beams are in contact with the concrete. This depends upon speed of forward travel of the machine, and upon the widths of beams in contact with the surface. They suggest that an economical average speed of travel is less than 2-ft. per minute, and that full consolidation can be achieved only if the concrete receives a vibration of not less than 4g for at least 30 seconds.

An interesting development which may have applications in dock and harbour work is the making of concrete by the "shock" process[5] developed by Dutch engineers, in which a very dry mix is employed with a water-cement ratio of from 0.3 to 0.4; this is very carefully placed in finished moulds fixed to special shock tables and consolidated by applying from 200 to 210 shocks per minute. The concrete, still in the moulds, is then cured in special rooms at 80 to 120 degrees Fahrenheit for a period of from 5 to 8 hours.



Reconditioning R.C. Columns and Beams at Consett Ironworks.

The compactness of the product may be attributed to the method of suddenly arresting the fall of the concrete particles; the latter are forced very close together so as to fill all voids, superfluous air and water being squeezed out. The ideal to be aimed at in mixing

[1] "The Deterioration of Concrete in Structures" by F. M. Lea, O.B.E., and Norman Davey, D.Sc., M.I.C.E. Paper No. 5722, Inst.C.E. May, 1949.

[2] "Cements resistant to sea-water" by R. Gallo. *Chemical Age*, 57, 1469, p. 318, 1947.

[3] "Concrete Design and Workability" by H. Smith. *Civil Engineering*. September, 1946.

[4] "The Use of Spreading and Consolidating Machinery in Concrete Roads and Runway Construction" by R. Lacey, A.M.I.C.E., and W. M. Robb, A.M.I.Mech.E. Paper No. 5539, Inst. C.E. January, 1947.

[5] "Shock Concrete" by T. R. S. Kynnersley. *Indian Concrete Journal*, February, 1948.

Concrete in Dock and Harbour Construction—continued

and placing concrete is to produce a highly workable mix with minimum water content

Prestressed Concrete for Harbours and Docks.

The advent of prestressed concrete has brought in a new material of outstanding value to the dock and harbour engineer, which has already proved its worth in this particular field. Reconstruction of the quay wall at Le Havre, to which reference has already been made in these columns, was greatly facilitated by the use of prestressed reinforced concrete lintels to span the space between cofferdams sunk in the debris of the previous work damaged during the last war. These lintels were reinforced with prestressed steel wires of 0.2-in. diameter grouped around a central spring; the

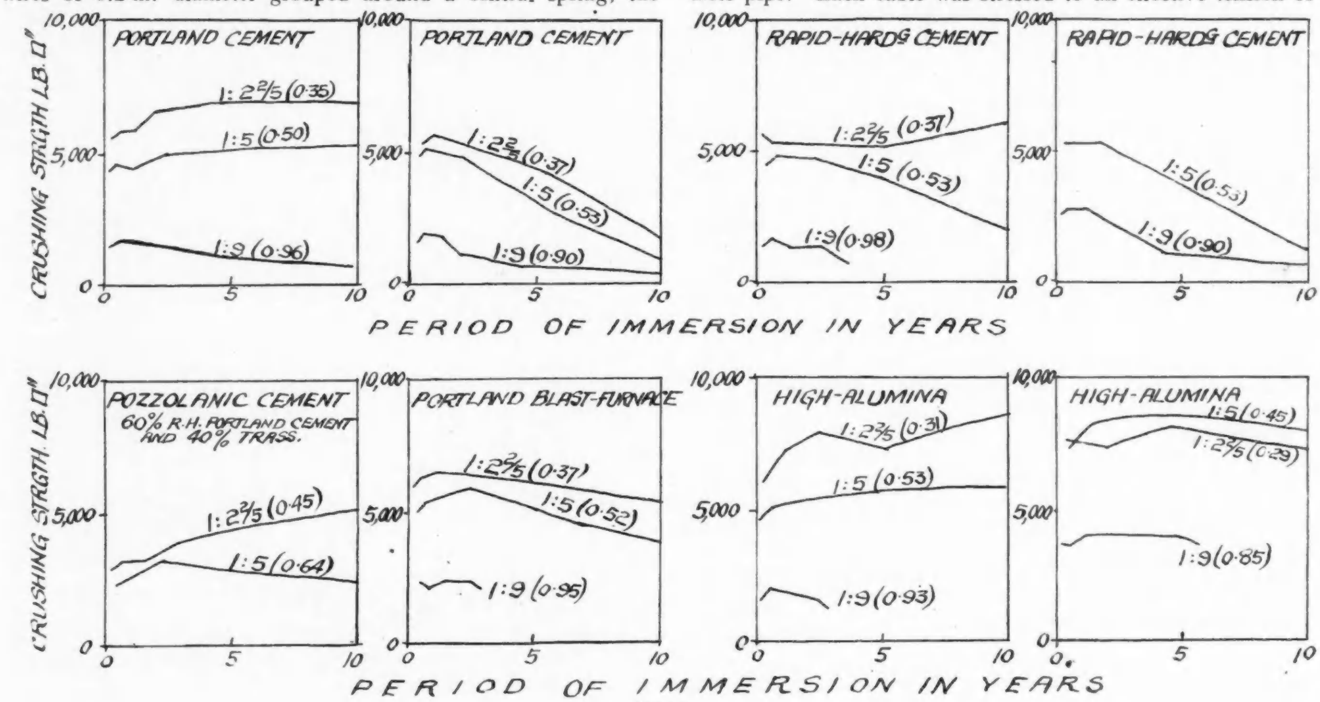


Fig. 2.

wires were painted with bitumen and the cables were wrapped with paper and painted. All cables were anchored by cones of the Freyssinet type except those on the seaward side, where the wires were bent outwards and cast in the concrete. Lintels were lifted into position by crane and the quay brought up to the level by a facing of pre-cast blocks backed by concrete.

Another remarkable example of the application of prestressed concrete to quay wall construction was the work carried out at Brest before the last war, where self-floating caissons of prestressed concrete were employed. Each caisson was 72-ft. long, 49-ft. high and 43-ft. wide and was placed in a depth of 30-ft. of water on foundations prepared by a moving caisson. An interesting feature of these caissons were their flexibility, allowing them to deform as much as an inch during alignment.

Since the last war this form of construction has again been employed at Brest for the construction of a deep water quay. Here the caissons were formed of prestressed concrete around a metal-framed working chamber; each caisson weighed 3,000 tons and contained 76 tons of steel, of which 6 tons were prestressed. Caissons were also employed in the construction of a cofferdam for the Laninon graving docks, Nos. 8 and 9. Each weighed 1,200 tons and were 59-ft. long, 46-ft. high and 30-ft. wide. The Freyssinet system of prestressing was employed using 12 wires of 0.2-in. diameter in each cable, which was grouted after tensioning. These caissons were later incorporated in the construction of the new quay.

At the present time 24 prestressed concrete caissons designed by Dr. Mautner of the Prestressed Concrete Company are under construction at Leith Dock, Edinburgh, where they are being employed for a new deep water quay and will be used under compressed air. Several caissons have been launched successfully, and it is expected that the work will be completed at the end of this year. The design incorporates the Freyssinet type of cable which is grouted on completion of tensioning.

Another interesting example is the use of prestressed concrete for the repair of a river quay wall which failed at Ghent; this was anchored back with prestressed cable to a prestressed concrete wall built in the ground 52-ft. from the quay face. The cables are spaced at 11-ft. centres, and comprise 32 wires each of 3/16-in. diameter contained in a steel tube which is surrounded by a concrete pipe. Each cable was stressed to an effective tension of 53 tons and was grouted for protection against corrosion. Construction of the anchor wall was carried out in lengths of 150-ft., the wall being 9-ft. high and 1-ft. 4-in. thick at the base, tapering to a thickness of 8-in. at the top. Each section of the wall is prestressed by four cables of 56 wires each 3/16-in. diameter. This work was carried out under the direction of Professor Magnel, his own types of sandwich cables and anchorages being used throughout.

Prestressed Concrete Piles

Prestressed concrete piles have been developed in Belgium, where two different methods of prestressing during driving have been employed. In the first system the pile takes the form of precast sections, each about 3-ft. long with a groove at each corner into which fit steel bars of ¾-in. diameter. Four of the latter are attached to the pile shoe, several of the pre-cast units are placed in position and finally the pile cap is atached, to which the bars are fixed and tensioned. As pile driving proceeds the pile cap is removed, new units are added and the pile cap replaced; simultaneously, cement grout is poured into the corner grooves. In the second system, hollow lightly reinforced concrete piles are cast, and a cable is fixed to the shoe which passes through the whole length of the pile. This cable is tensioned before lifting and driving, and is removed after driving.

Many vertical and raking prestressed concrete piles were successfully employed in Trinidad, designed by Dr. Mautner; they are 80-ft. long and have an external diameter of 29-in. and an internal diameter of 22-in. and were manufactured by pre-tensioning on long beds.

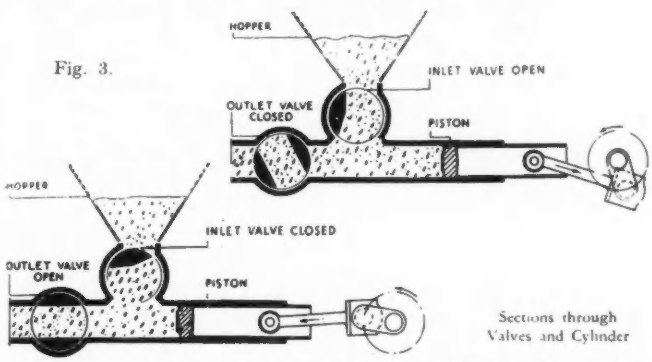
Concrete in Dock and Harbour Construction—*continued*

Special Applications of Prestressed Concrete

There are a number of special problems in maritime works which can be solved by applying prestressed concrete methods. For example, in 1937 French engineers considered its possible use for the Jument d'Ouessant lighthouse. This matter is still under discussion and so far the method has not been employed in this field, although it appears to be admirably suitable for any type of work where high stresses and slender sections are required. By using prestressing methods for a lighthouse, it should be possible to reduce the weight and cross-section of the structure very considerably over what is now considered necessary when employing conventional methods.

An interesting problem was presented after completion of the main structure of the Dockyard Station at Le Havre in 1933, when it was found that general settlement was taking place. It was therefore decided that the weight of the structure should be transferred to firm gravel at a depth of 100-ft. below ground level, the design of this work being entrusted to Freyssinet, one of the pioneers of this technique. Lightly reinforced concrete blocks were cast between the existing footings and were tied together by post-tensioned steel bars, thereby converting the footings into a series of continuous beams. Vertical holes were then left in these beams for driving the 2-ft. diameter hollow cylindrical concrete piles employed, each reinforced with longitudinal and helical wires and cast in short lengths as driving by jack proceeded.

Fig. 3.



Sections through Valves and Cylinder

In order to obtain concrete with high early strength, pressure and vibration were applied in addition to steam heating to compact the concrete. After this treatment had been completed, driving continued, but great care was taken to avoid heavy stresses being imposed on the concrete less than 8 hours old; normally, a complete pile was driven to the full depth in four days. After driving, the spaces between the piles and the foundation beams were filled with concrete.

Prestressed concrete has also been applied to the construction of beams on site, for the support of an existing structure for underpinning, or for the movement of a complete building. This is the kind of problem which may confront a dock engineer who has to deal with old buildings or with awkward foundation problems. Magnel used this method for raising two towers of the ancient bridge at Tournai; each tower weighs 2,800 tons and was lifted 8-ft. by jacks operating between two horizontal prestressed concrete frames constructed in sections in the base of the towers.

Electro-Concrete

In this country the dock engineer is fortunate in that he rarely has to place concrete when the temperature is below freezing point, but in other parts of the world, and notably in Russia, in some parts of the United States, in Canada, Scandinavia, or Germany, builders and contractors devote special attention to the problem of concreting in frosty weather if they do not wish to lose valuable time during winter months.

In Russia a great deal of study has been devoted to this problem and an interesting review of the methods adopted there has been given by Kurt Billig.* He has pointed out that under Siberian winter conditions methods like heating the concrete components, or the admixture of chemicals alone, do not go far in preventing freezing. Since many of the hydro-electric plants in that part of the country are built on ground which is frozen all the year, it was essential that a solution should be found to this problem and there was no time for laboratory experiments.

The experience gained in this work has been summarised in "Code of Practice for Building Work During Winter," published in 1933, in which a chapter is devoted to concrete and reinforced concrete structures. Heating concrete aggregates and steam heating concrete cast in moulds are methods well known in Europe and in the United States, but heat treatment of concrete by passing an electric current through it has been applied on a commercial scale only in Russia.

The principle is quite simple. Wet green concrete is to a certain extent a conductor of electricity, and at low voltages quite large quantities of current may be passed through it. Owing to the resistance of the concrete, the electric power is transformed into heat, thereby raising the temperature of the cold concrete; this increased temperature may be employed usefully in accelerating the setting and hardening of the concrete, or in preventing it from freezing at too early a stage. Current is passed through the green concrete by the use of two or more poles, the circuit being closed by the fresh concrete itself. Only alternating current may be used, because direct current will cause decomposition of the water by electrolysis.

In Russia much experience has been gained in the application of this process to pre-cast units like columns, beams and piles, and in monolithic structures like flat and ribbed floor slabs, concrete frames, and light reinforced concrete foundations. No satisfactory results have yet been achieved by this technique in dealing with concrete tanks, walls and other parts with complicated reinforcement.

Billig states that the additional cost of electro-concrete varies mainly with the total quantity of concrete to be treated and with the daily output; an average figure is from 25 to 30 per cent. of the concrete price, for a total minimum of 1,000 cub. metres (1,308 cub. yds.) and a regular daily output of 20 cubic metres (26.16 cub. yds.).

According to Russian Temporary Instructions, the highest temperature of the regime should at no time exceed 70 degs. C., and shall preferably not exceed 50 degs. C during the first 24 hours of treatment; rate of temperature increase should be even and limited to 6 degs. C per hour. It may be increased to 10 degs. C in a second step, but this should take place not earlier than 20 hours after the beginning of treatment. Duration of active treatment should not exceed 48 hours and the maximum temperature 50 degs. C. With a maximum temperature of 70 degs. C, in a two-step regime, duration of active treatment should be limited to 36 hours.

Cooling down should last not less than 24 hours, but in very massive structures such as those commonly found in dock construction, no special precautions are required. In the case of a very thin structure, rapid cooling down of the concrete can be prevented by using well-insulated moulds. Alternatively, cooling of the concrete can be retarded by switching on the current for short periods and thus replacing excessive heat losses.

Concrete Mixing and Placing

In all works where large quantities of concrete have to be produced and placed, it is worth while taking a great deal of trouble to ensure that the finished product is of uniform quality and strength, and this can be achieved only by constant routine checking of the accuracy of cement weighing machines and water measuring devices. The concrete mixer is the main factor in the production of good concrete, and to-day much more attention is being devoted to the attainment of high mixing efficiency than was previously the case.

Although weigh batching machines operating on the beam and jockey-weighing principle appear to be the most satisfactory equipments, they may suffer from clogging of the knife edges, and therefore it may well be that in the future hydraulic weighing machines will be adopted. It is found in practice that vertical water measuring tanks give reasonably accurate results if they are cali-

*"Electro-Concrete" by Kurt Billig, A.M.I.C.E. Paper No. 5477, Inst. C.E. October, 1945.

Concrete in Dock and Harbour Construction—continued

brated properly, and it seems hardly necessary to emphasise the importance of careful maintenance of this part of the plant, because the water-cement ratio is extremely important in determining the strength of the concrete.

Remarkably fine research has been undertaken by Murdock on this matter,[1] and he has emphasised that some difficulty arises in determining the efficiency of concrete mixers because of the number of factors involved. He states that there appears to be a general failing in rotating drum mixers, large and small, in the lack of inter-change of materials from one end of the drum to the other. Continuous mixers and pan mixers also show lack of uniformity, and he believes that further research is necessary to evolve designs of mixers which will overcome the trouble revealed by his research and can at the same time be operated economically.

An important point which he brings out is that until improved types of mixers are available, much can be done to improve the uniformity of concrete by paying attention to the sequence in which the various materials are placed in the loading hopper, and by discharging into an intermediate hopper before transporting to the point of deposition.

The layout of the plant used on the construction of blocks for Kilindini Harbour[2] is of considerable interest to those concerned with similar work. A goliath crane with a span of 55-ft. was used for handling the concrete blocks in the main blockyard. All blocks were 6-ft. wide on the face, and the 55-ft. span allowed for casting four rows of blocks across the width of the blockyard and for two gantries, each running the length of the yard and carrying two lines of jubilee track for transporting the mixed concrete from the mixer to the block moulds. As the block moulds were 4-ft. high, the blockyard gantries had to be a few inches higher.

The programme of construction demanded 16 blocks to be made every day, and since the lifting time was 7 days, the blockyard had to be long enough to contain the output of 8 days. Since there were four rows of blocks cast in the yard, and the block moulds required an average length of 12-ft. 9-in. to give reasonable clearance, the length of the yard had to be 407-ft. Two main blockyards were built at Kilindini, because the first two liner berths completed were put into use before the remainder of the work was put in hand, and the space occupied by the original blockyard was required for the permanent railway tracks and roads.

Concrete was supplied to each blockyard from an electrically-driven mixer of 1 cub. yd. capacity, arranged at a level from which it could conveniently discharge into jubilee skips standing on the blockyard gantry. At the other end of the yard the goliath rails were extended for a length of about 500-ft., the space between them being used for stacking the blocks four or five courses high during the period of two months specified for maturing. Space between the goliath rails in the stacking area was not concreted, but strips of concrete 6-in. thick were laid in the blockyard to serve as foundations for each row of moulds. Open drains were provided between them to cope with heavy tropical rainstorms experienced at certain times of the year.

Where large volumes of concrete have to be placed, it is wise to instal a central batch mixing plant, the location of which should be as near as possible to the centre of gravity of the deposited concrete. Thus, the plant used for the construction of the Pitlochry Dam[3] should be of considerable interest to harbour and dock engineers. The dam is of the gravity type, 510-ft. in length between the cut-off walls and 60-ft. in height from foundation-level to the spillway crest.

The construction programme demanded a peak output of 300 cub. yds. a day of concrete. The central mixing station comprises a 1 cub. yd. mixer with appropriate batching plant. The latter is a timber-framed structure with five bins to hold the four gradings of course aggregate, namely: 3-in. to 1½-in.; 1½-in. to ⅜-in.; ⅜-in. to ⅛-in.; ⅛-in. to 3/16-in., and sand—all specified for the various mixes. The bins are fed by grab from adjoining stock piles, and provision has been made for heating all aggregates during frosty weather.

Proportions of each batch are measured by volume in gauge boxes located directly beneath each bin, which discharges on to a conveyor belt whence they are carried to the mixer. Sheds for storage of tested cement adjoin the mixer, lorry access being provided by means of an earth ramp from the existing road. Cement in bags is trucked from shed to mixer. Mixed concrete collected in a wet hopper below the mixer feeds concrete skips, generally of 2 cub. yds. capacity; thereafter distribution to the various sections is carried out by derrick.

The use of derricks, for placing concrete, was made with great success on the construction of the Cliff Quay Power Station, Ipswich, and some particulars of their arrangement have been given by Dawson. These derricks had jibs 120-ft. in height and could pick up loads of 7 tons or 10 tons at a radius of 90-ft. In this case two 7-ton derricks were used to deal with the concrete; output from the mixers was 1,000 cub. yds. a week, and was later increased to 1,500 cub. yds.

One problem was that there were three or four different mixes and the concrete was being conveyed to half-a-dozen sites at the same time by concrete pump, by railway and by other means.

Pumped Concrete

During the last few years the use of pumped concrete has increased considerably, and there is much to be said in its favour. From his own experience and study of the method, the author is convinced that the secret of success lies in a well-trained gang who will keep the plant in first class condition. Every care should be taken to ensure that all pipes and bends are thoroughly cleaned out at the end of a shift and that the valves and other parts work freely. Suitable choice of aggregate is another important point.

The diagram (Fig. 3) shows the operating principle of the Blaw Knox Model 160 concrete pump. It is a single-acting horizontal piston pump connected to a conical receiving hopper incorporating a mechanical agitator. The valves are operated by double-acting cams and the cam rollers are enclosed in a banjo-type casing. Valve operating gear embodies a spring-loaded device designed to prevent damage should the valves be obstructed when closing, a design feature of considerable value in avoiding breakdowns.

An interesting example of its practical application is the work recently carried out for the Middlesex County Council in connection with main drainage, for which the consulting engineers were Messrs. J. D. & D. M. Watson, MM.I.C.E., and the contractors W. & C. French, Ltd. The pump used here worked in conjunction with a Blaw Knox weigh batcher which fed two 18/12S Rex mixers, the working cycle of the latter being so arranged that a constant feed was maintained to the hopper of the concrete pump.

The mix used on this work was 4 : 2 : 1 with a 2-in. slump, the two mixers being arranged to discharge directly into a chute leading to the hopper of the pump. There were two bends and a lift in the pipe-line which had an equivalent length of 600-ft. A team of four men operated the mixing and pumping unit. In wall construction some 74 cub. yds. of concrete was placed in a normal working day, inside close shuttering from a scaffold well above floor level. An interesting idea is the use of a flexible steel hose fitted to the end of the pipe-line. The hose was rigid enough to withstand the thrust of the concrete, but flexible enough to permit of easy movement over a wide area, thereby avoiding the need for hand distribution from a single point at the end of the pipe-line, the latter itself also having a certain amount of inherent flexibility.

The Blaw Knox pump, mounted on a rigid steel frame carried on four pneumatic-tyred wheels, was driven by a 34 h.p. oil engine; which had a stroke of 12-in. and a bore of 6¼-in., with rubber rings fitted to the piston to keep the cylinder walls clear of concrete. A flow of water under pressure flushed the tail end of the piston when the machine was working. Drive for the pump was taken through a plate clutch and bevel reduction gear, Vee belts and a 2-speed gear box, final drive being reduction spur gears to

[1] "The Efficiency of Concrete Mixing Plant" by Leonard Murdock, Ph.D., A.M.I.C.E. Paper No. 5613, Inst. C.E. November, 1948.

[2] "Kilindini Harbour, Mombasa" by C. C. Buckler, O.B.E., M.I.C.E. Paper presented to the Works Construction Division of the Institution of Civil Engineers, 10.5.49.

[3] "Pitlochry Dam and Power House; and Clunie Dam" by J. A. Bennett. Paper presented to the Works Construction Division of the Institution of Civil Engineers, 10.5.49.

Concrete in Dock and Harbour Construction—continued

the crankshaft. In high gear the pump made 46 working strokes per minute and in low gear 23 strokes per minute. The 2-speed gear was claimed to be a great advantage because the low gear would be brought into operation when the full output of the pump could not be handled conveniently on the working site.

In a concrete pump there is considerable wear owing to the nature of the material handled, and therefore component parts are made renewable, being easily and rapidly removed and replaced by spares with minimum disturbance to normal operation of the plant. The pipe-line for the above-mentioned consists of 6-in. diameter steel tubing in various lengths up to 10-ft., with bends of 45 degrees and 22½ degrees available for obtaining quick access to the actual placing site. Couplings are quick-acting with rubber seatings, fastened by wedges, which facilitate rapid assembly and dismantling. The pump is stated to have a maximum capacity of from 15 to 20 cub. yds. an hour and will pump concrete in a straight line up to 1,000-ft. horizontally, 100-ft. vertically, or a combination of each, with an aggregate not exceeding 2-in. in size.

In the operation of a concrete pump, there are three very important points to remember. Firstly, the pump must not be run without connecting the water supply to the cylinder; secondly, the pipe line must be lubricated when pumping is started. A wet paper plug made of cement bags should be inserted in the pump, the first batch from the mixer consisting of two parts of sand, one part of cement, and enough water to form a slurry. Later batches should be to the required specification. Thirdly, if the inside of the pipe is rusted or dirty, extra cement should be added to the mix for the first two hours of operation to ease the flow and to obtain a polished bore in the pipe-line.

Prefabricated Concrete Members

There is much scope for the application of prefabricated reinforced concrete members in dock and harbour construction, and excellent experience of this was gained during the war on the construction of the Naval Forts.* Thus, the base of each tower consisted of four hollow-reinforced concrete members each 85-ft. long, 6-ft. high, 4-ft. 6-in. wide at the bottom and 5-ft. 6-in. wide at the top. Floor, sides and roof were 5-in. thick. At the inter-section of the four members, the junction was concreted solid to provide a good anchorage for the four legs of the tower.

The hollow cylindrical reinforced concrete legs of the towers were 65-ft. high and had an external diameter of 3-ft. and an internal diameter of 2-ft. Each leg was pre-cast in three separate sections each weighing 5 tons, and was about 17-ft. long with the main 1¼-in. diameter bars protruding about 4-ft. from each end.

Great care was taken in the working out of the reinforced concrete design. A high grade concrete was employed with a mix of 1 : 1 . 2 : 2 . 4, and where possible the slump was limited to 2-in. Simplicity and high speed of construction were both achieved by eliminating as far as possible beams and columns with their accompanying complications in steel placing and centering. The interesting point is that this work practically involved the introduction of a new constructional technique, and from this aspect alone it is worth careful study by dock and harbour engineers.

Reinforcing steel in slabs was pre-asembled in large mats, as were the cages of cylindrical reinforcement of the towers. The mats and cages were partly wired and partly spot-welded, made sufficiently rigid to be hoisted into position; plain round bars were employed, hook ends and bends in the reinforcement being carefully avoided. Steel reinforcement was arranged in such a manner that the concrete could be poured in lifts of up to 8-ft. in vertical height, thus reducing horizontal construction joints to a minimum.

Another very interesting feature of this work was the close investigation of the effect of impact during a "crash dive," much information on this problem being obtained from scale models. Sharp impact of small models on the bottom of the tank indicated the need for buoyancy chambers to cushion the blow to a 4,000-ton structure striking the sea bottom. The four columned structure of each fort had to be made strong enough to resist the impact of victualling ships coming alongside in rough weather; in practice, ships of 2,000 tons berthed against the fenders and greater impact probably occurred, than the 40-tons magnitude of blow expected

It is interesting and significant to note that even in very rough weather the crews of these forts never suffered any inconvenience. In the Naval Forts the large cylindrical towers, 24-ft. in diameter, offered very little resistance to wave movement, waves rising and falling and passing around the towers without causing shock or even much splash. It therefore seems to the author that concrete structures of this type might well be considered for certain types of jetties, especially for loading tankers and similar work.

Conclusion

When all is said and done, the author believes that good concrete can be made only by careful attention to detail and by thorough workmanship of the highest quality; he fully agrees with the engineers of the Ministry of Works, who set their face against the use of integral water-proofers and similar substances, believing that only high quality concrete can provide adequate water-tightness.

Aggregates should comply with the appropriate British Standard; mixing should be controlled and the quantities of materials used carefully measured; and the concrete should be fully compacted in the form work. With such control in operation, successive batches of concrete will be of much more uniform strength than in those cases where such precautions are not taken. Lower average strength, resulting in a saving in cement, can then be permitted and yet the strength of each batch can be guaranteed not to fall below the minimum specified.

*" The Construction of Britain's Sea Forts " by J. A. Posford, M.A., A.M.I.C.E. Inst.C.E. June, 1947.

Pneumatic Locks—*continued from page 53*

Conclusions: (1) The idea of the balanced pneumatic lock operated by compressed air consists of the substitution of a prism of water by a prism of air. This appears to be attainable and should be practicable if the difficulties of construction can be surmounted.

(2) Pneumatic locks based on the principle of a bell operate easily, without friction against walls, but require a foundation of such a depth as not to be practicable.

(3) Pneumatic locks, balanced and operating in tandem, based on the principle of pistons, overcome the fundamental obstacle of friction between the lock walls and the mobile platform. Reduction of this friction by water lubrication on the lock walls can give satisfactory results. However, it is necessary that the pressure on the packing shall be variable.

(4) The main problem is to achieve exact vertical movement of the mobile platform.

(5) The problem is very much complicated by the compressibility of air, as well as by the necessity for the lock walls to be made perfectly air-tight.

All the difficulties to which we have referred can be examined more fully on a model, and probably can be later eliminated in the course of actual construction. The cost of such a model would without doubt be covered by the considerable benefits obtained by the adoption of pneumatic locks in suitable conditions.

Some Modern Cargo Handling Appliances

(Continued from page 57)

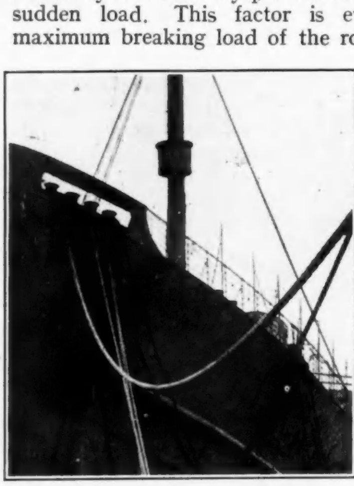
left Port Authorities—and indeed the nation—with no option but to use open ground (often the sites of destroyed premises) for storing goods which would otherwise have been warehoused. By no other means, in fact, could the country's necessary reserve stocks of certain foodstuffs be held. The importance of the mobile crane in the export drive has already been emphasised and it will be obvious how much this machine had done to alleviate the special difficulties which have arisen in this sphere in the post-war years. The mobile crane has undoubtedly become a permanent feature of port equipment, indispensable, if the present standards of efficiency are to be maintained.

A machine which it is hoped will ultimately become as useful is the fork lift truck. The use of this for cargo handling is, however, in the experimental stage and in the next article its great potentialities and the difficulties to be overcome before it, in its turn, can become a common and indispensable feature of port work will be examined. *(To be continued)*

Nylon Ropes for Marine Purposes

In addition to the uses to which nylon has been put in the past, there has recently been developed a new, and a strikingly different side, to the industry—a side particularly interesting to those concerned with shipping.

Nylon has been found to be suitable for spinning into a rope with unique properties and with an unusual impact strength that makes it ideal for mooring, towing, anchoring and similar purposes. Ropes made from nylon possess exceptional tensile strength—about twice that of manila ropes—a high degree of elasticity, and exceptional resistance to shock loading. The extensibility and elasticity provide for the absorption of energy under sudden load. This factor is even more important than the maximum breaking load of the rope.



S.S. *Empire Fowey* moored with nylon ropes at Dalmuir Basin, Glasgow.

An outstanding example of the value of nylon rope for mooring is the case of the s.s. "Empire Fowey". This 17,528 tons gross vessel was undergoing conversion at Linthouse, Govan, and had many mooring troubles while she lay in Dalmuir Basin, Clydebank.

The natural ebb and flow of the tide, and disturbances created in the basin by vessels passing up and down the river, caused her to range violently at her berth. Manila, sisal and wire ropes were parting so frequently under the strain that nylon mooring ropes were tried. Two 100 feet lengths of 8-in. circumference were put into operation. The remainder of the moorings were then able to take the strain easily, and, gradually, to act in unison with the nylon, because the new rope provided the strength and elasticity to absorb the shock load.

A tug owner in Holland also had an interesting experience in a test he carried out. He fastened one end of the nylon rope to a bollard on the quayside and the other to a tug in the river. The tug was then set going at full speed ahead. When it had reached the limit of the rope, it was easily held. This does not surprise the rope-maker, because the force exerted was well within the capacity of the rope, but the point that impressed the tug owner was that, when the engines were shut off, the nylon rope gradually recovered its original length and the tug was slowly pulled back to the quayside.

Under test, nylon rope has been shown to possess a remarkable degree of extensibility under load—in some cases extending to 40 per cent. above the original length before breaking. Nylon is also remarkably elastic, recovering to within 10 per cent. of original length after the application of a load 50 per cent. of the ultimate breaking load.

Ropes made from manila, hemp and other vegetable fibres are almost completely lacking in this characteristic. They can be stretched under load, but such stretch is mainly the result of the deformation of the component yarns and strands, and the slippage, or fracture, of filaments contained in the rope body. Consequently, stretching a vegetable fibre rope to any degree reduces the length of life of the rope and impairs its reliability.

Because nylon is in itself extensible and elastic, nylon ropes can be stretched repeatedly without fracture of the component filaments. Some slight deformation of the rope structure is bound to occur, but this is not of a serious nature and the progressive deterioration of the rope is relatively small. Hence its life, in terms of maintained breaking load, is much greater than that of vegetable fibre ropes, other conditions being equal.

In the laboratories of British Ropes, Limited, at Leith, Edinburgh rope is subjected to the most inconsiderate treatment in order to test these qualities. It is stretched, over-loaded, jerked, soaked in water, bathed in chemicals, buried in garden compost and exposed on the roof for months.

In a weatherometer machine it suffers the extremes of atmospheric conditions. Jets of water beat on it for hours on end to simulate torrential downpour. Violet rays reproduce in days the effects of months of tropical sunlight. Miniature gales are manufactured and added to the general tests, so that in a matter of hours the effects of months at sea, in Arctic weather or Mediterranean sun, can be accurately gauged.

Such treatment produces remarkable results. It is proved that the gain in weight of nylon yarn or rope after immersion in water is considerably less than that of any other cordage fibre. Tests indicate that nylon rope increases in weight by not more than 22 per cent. when saturated for 72 hours. This low moisture affinity means that nylon rope does not swell nor harden when wet. It retains the same ease of handling and pliability either wet or dry.

Nylon will withstand contact with a number of chemicals which degrade normal fibre ropes, but, to avoid risk of failure, the same care should be taken in the use and storage of nylon as would be taken with any other type of rope. Tests indicate that insects, which normally feed on vegetable fibre, find nothing to support them in nylon cordage. Also it is remarkably resistant to moulds and other micro-organisms, showing little or no loss in strength after soil burial tests. For this reason, it is considered unnecessary to rot-proof nylon lines for marine use. Laboratory tests and the actual performance of ropes and fishing lines in varying marine conditions have amply confirmed these conclusions.

Surface abrasion of a rope can be one of the most important factors in reduction of tensile strength.

Internal abrasion between the strands in the centre of the rope can be produced by the action of the strands upon each other or by the penetration of sharp particles of sand, soil and other substances which shear the filaments.

Research work has shown that nylon rope withstands external abrasion equally as well as manila or hemp rope, but due to the very fine filaments from which the rope is constructed, surface abrasion soon produces a fluffy appearance which may mislead the user into thinking that there is a marked reduction in strength. In actual fact, it is usually found that, because these fine filaments which have been fractured on the outside of the rope are such a small proportion of the whole, the tensile strength of the rope is little impaired.

Like all other fibres, nylon suffers some degradation when exposed to intense sunlight. Such deterioration is no more marked than for other cordage fibres. The strength of both nylon and manila rope is progressively reduced on exposure to bright sunlight over prolonged periods. Nylon rope, being stronger before exposure, maintains a degree of superiority throughout.

Nylon will not support combustion, but, if exposed to a naked flame, it will melt and form a glue-like substance. This flame-retarding property should prove valuable wherever there is fire risk, as in tankers.

Of course, if nylon is treated or doped in any way, such doping-agent may support a flame, but, under normal conditions, nylon rope can be considered to be non-inflammable.

KNOTTING AND SPLICING

Doubts have been expressed about the knotting and splicing, and some little difficulty has been reported in splicing. This is mainly due to the tendency of the rope to stretch or extend under tension and thus reduce the cross-sectional area. Knots, carefully tied, are in fact just as secure as those on any other type of cordage. In splicing, it is found that there is no trouble if more tucks are used than in a normal splice. It is recommended that in a short or butt splice the minimum number of tucks should be five.

The initial cost of nylon is higher, but it should be remembered that it permits the use of a smaller size for a given strength, resulting in a saving in weight. Additionally there are, of course, its longer life, freedom from rot, better appearance and better handling qualities.

Mechanical Handling Exhibition

World's Largest Display of Labour-aiding Equipment

The Mechanical Handling Exhibition, to which we briefly referred in our issue of April last, will be held at Olympia, London, from Tuesday 6th to Saturday 17th of this month. As previously stated, the exhibits will cover the full range of equipment for the handling, lifting, stacking and short-distance transportation of goods, and our readers will be interested in the following details of exhibits which will be shown by a number of our regular advertisers.

ASSOCIATED BRITISH OIL ENGINES, LTD.

A range of small engines manufactured by Petters, Ltd. (Small-Engine Division), Causeway Works, Staines, and two models of the Petter-Fielding horizontal diesel engine, together with self-contained diesel-electric generator set, manufactured by J. & H. McLaren, Ltd., Airedale Works, Leeds, 10.

BRITISH ROPES, LTD.

Steel wire ropes for mines, elevators, cranes, hoists, and all types of contractors' plant and excavating machinery. Blue Strand Preformed steel wire ropes, "Viking" nylon rope and slings, sisal transmission ropes, square plaited driving ropes, packing cords, canvas tarpaulins and bright steel bars.

BUTTERS BROS. & CO., LTD.

Owing to the fact that this firm's products are too large to be shown on an exhibition stand, models of cranes designed for use in shipbuilding, building construction, timber yards and factories, will be displayed. Also a large range of photos of their cranes.

CHASESIDE ENGINEERING CO., LTD.

The Chaseside loading shovel: A machine will be displayed taken from the range of ½, ¾ and 1 cu. yd. capacities. There are in all nearly 20 different types suitable for a variety of jobs. The firm is prepared to demonstrate that this item of equipment is well within the reach of the smallest firm with only a small material handling problem.

The Chaseside brickstacker attachment: This is suitable for use with the majority of the company's range of shovels. It is able to load up to 3,000 bricks per hour from brick-stack up to 16-ft. high scaffolding. The attachment can be readily adapted to the loading of items other than bricks.

The 2½ cu. yd. dumper and the 2-ton crane: In addition to the 1-ton crane attachment, suitable for rapid and easy conversion of the ½ and ¾ cu. yd. shovel, the Company also manufactures and will show a 2-ton crane which, from the chassis point of view, follows very much the same lines as the shovel.

GEORGE COHEN SONS & CO., LTD.

The Jones KL mobile cranes—4-ton, 2-ton and 15 cwt.—will be shown. Also Douglas industrial power trucks, gravity roller conveyors, "Hoistmaster" electric hoists, manually-operated overhead cranes, winches, etc.

COVENTRY CLIMAX ENGINES, LTD.

A diesel FTF 412 fork lift truck 4,000 lb. capacity at 20-in. load centre at 144-in. lift, will be exhibited, and a diesel FTF 512 fork lift truck with complete spark arresting equipment. This is a 5,000 lb. capacity truck at 20-in. load centre at 144-in. lift height.

Also a petrol fork lift truck, 1,000 lb. at 15-in. load centre by 72-in. lift; a 2,000 lb. diesel fork lift truck at 15-in. load centre by 84-in. lift; and a complete CDQ diesel power transmission unit.

In addition to these exhibits, there will be displayed an assortment of fork-truck attachments.

CRONE & TAYLOR, LTD.

Mainly mobile machines will be shown, the most prominent being a 40-ft. Mammoth stacker. The outstanding features of the stacker are: extreme mobility, rapid height adjustment by means of power operated hydraulic jacks, and the fact it is capable of handling coal at the rate of 80 tons per hour.

Twenty-foot mobile bag stacker: This is fitted with a 24-in. wide troughed belt and a detachable feed hopper to enable the machine to be employed on either loose materials or bags.

ELECTRO-HYDRAULICS, LTD.

A complete range of fork lift trucks incorporating all the latest improvements and attachments.

Special export model of a battery-electric 4,000 lb. capacity truck, with 130-in. full free lift, and equipped with side-shifter mechanism, load guard and overhead guard. Mark VI, 30 cwt. battery-electric model, equipped with special brick forks. Mark IV, 2-ton petrol-driven fork lift truck. Mark II, 30 cwt. petrol-driven fork truck, equipped with hydraulic shovel as a detachable ancillary unit. Mark, XVI, 6,000 lb. 12-ft. lift diesel driven fork lift truck on pneumatic tyres. Mark VII, 2,000 lb. 9-ft. lift, petrol-driven truck with pneumatic tyres.

FRASER & CHALMERS ENGINEERING WORKS. (Proprietors: THE GENERAL ELECTRIC CO., LTD.).

A scale working model of the Marshall tippler, and certain conveyor machinery and electro-magnetically operated vibrating equipment comprising conveyors, feeders, foundry shake-outs, screens, etc., will be exhibited.

THE GOODYEAR TYRE & RUBBER CO. (GREAT BRITAIN), LTD.

Included in the range of Goodyear industrial rubber products at the Exhibition will be a selection of conveyor belting for a wide variety of applications, and various types of industrial hose for oil, petrol, acetylene, air and water.

Among types of hose shown will be heavy-duty oil suction hose, designed for loading and unloading ships at docks and stations, and hose for sea loading connections of ship-to-shore pipelines, which is made in 2-in. to 8-in. sizes.

R. H. NEAL & CO., LTD.

The Type R and the Type GM mobile cranes will be exhibited.

The Type R—maximum capacity 10 tons at 11-ft. 6-in. radius. This new edition is the largest size mobile crane in the Neal range, and although its maximum capacity is rated at 10 tons (without the use of outriggers or other restrictions) with a 30-ft. jib, it is anticipated that one of its principal uses will be for those lifting problems requiring handling of medium-weight load at a large radius, such as 3 tons at 26-ft. radius, which is particularly useful for grabbing work, working on quay sides, etc. It can also be fitted with long jibs up to a maximum of 75-ft., which will enable high lifts to be obtained.

The Type GM—maximum capacity 15 cwt. at 8-ft. radius. This is the latest addition to the range of mobile cranes. It is a small but fully mobile model, incorporating the many patented features found in the larger sizes, and specially suited to the lighter lifting problems of builders, contractors and industrialists.

PRIESTMAN BROTHERS, LTD.

Various grabs will be exhibited, each one specifically designed for a particular application, and demonstrating the almost unlimited diversity of materials which are now regularly "grab-handled." An automatic model will be in operation, showing the grabbing and discharging of the material handled, and with traverse movement along an overhead gantry.

RANSOMES, SIMS & JEFFERIES, LTD.

Forklift 40 battery-operated telescopic fork truck with capacity of 2 tons at 1-ft. 6-in. centres and maximum height of lift, 10-ft. Models also available with 8-ft. and 12-ft. lifts. Forklift 20 battery-operated telescopic fork truck capable of lifting 1 ton at 1-ft. 6-in. centres with a maximum height of 10-ft. Models also available for 8-ft. and 12-ft. lifts.

E.N.U. 8 battery-operated elevating platform truck, platform 5-ft. long × 2-ft. 2-in. wide × 11-in. high above ground in lowered position; 4½-in. lift. N.U. crane truck, capable of lifting 10 cwt. on the jib at 5-ft. radius and of carrying 30 cwt. on the platform.

T.3 battery-operated tractor, capable of hauling a gross load of 6 tons. T.E. battery-operated tractor, capable of hauling a gross load of up to 30 cwt.

THE RENOLD & COVENTRY CHAIN CO., LTD.

In addition to showing their range of precision roller chains of the type widely used for power transmission on mechanical

Mechanical Handling Exhibition—continued

handling equipment, the firm will give particular emphasis in their exhibit to a special series of chains for conveying and elevating duties.

The new range in this series, known as the Coventry Mark 5 chains, has been specially designed to run on the same wheels as existing malleable chains. The Coventry Mark 5 chains have a special finish and are particularly suitable for running unprotected in unfavourable conditions.

The range of Reynold conveyor chains with both hollow and solid bearing pins will also be exhibited in full, and various attachments for conveying and elevating will be shown fitted to all these chains.

SIMON HANDLING ENGINEERS, LTD.

A working model of the pneumatic plants this firm supply for the handling of grain, coal and other free-flowing materials will be exhibited.

The plant will be of the open-circuit type, in which air and material are continuously induced into a special nozzle and piping system by vacuum pump, the material being extracted at an intermediate point and the air passing freely to atmosphere from the pump.

A vertical reciprocating vacuum pump, driven by electric motor through enclosed reduction gears and fluid coupling, will be on show, and this machine will provide the air current necessary to circulate material along an overhead piping system arranged along three sides of the stand, at the rate of five tons per hour.

In addition to the working pneumatic plant, the company are showing models of large grain-storage silos, floating pneumatic plants, and other mechanical handling systems of the more orthodox type, together with photographs and literature describing examples of the wide range of handling plant supplied.

THOMAS SMITH & SONS (RODLEY), LTD.

This company are exhibiting their 5-ton diesel mobile crane. It is mounted on pneumatic tyres and incorporates exceptional features to ensure rapid and safe operation. The crane is of robust construction, possessing a large margin of stability. Designed primarily for work on docksides, stockyards and warehouses, it can also be employed for building and constructional projects.

The fully revolving superstructure, in which is embodied the diesel power unit and machinery, rotates on a live ring of ten tapered rollers and is connected to the carriage by a centre post having an adjustable nut. Power is smoothly transmitted from the diesel engine through a hydraulic coupling and with separate friction clutches for the hoisting, slewing and travelling motions. Perfection of control in hoisting and lowering is obtained by the combined use of the hydraulic coupling and the rope barrel toggle clutch.

SPENCER (MELKSHAM), LTD.

The principle feature will be a small Pneumatic Plant of the type supplied for handling grain and other free flowing materials, and the plant can be seen operating.

The plant will be of the open circuit type, with alternate pipe lines, either taking from the top of a hopper by means of a special nozzle lowered into the material, as is done when discharging ships, barges, wagons, etc., or by means of a pipe line from the bottom of the hopper, as is frequently done when the material has to be transferred to a position some distance away.

A Spiral Sack Chute, several types of Conveyor Idlers, and a model of a Conveyor System will also be shown.

STANHAY, LTD.

A swivelling jib model of the firm's range of mobile pneumatic cranes will be shown. This is a new development, and further details will be available on the stand.

STEELS ENGINEERING PRODUCTS, LTD.

A range of mechanical handling equipment, including: Coles mobile cranes, Coles electric hoist blocks, overhead cranes and "Electric Eel" battery-driven trucks will be exhibited.

It may be possible to show the latest Coles 20-ton lift capacity mobile crane, but, if this is not possible, there will be on show the Coles 12½-ton crane on pneumatics, as displayed at the 1949 B.I.F.

All ratings are according to English standards and the 12½-tons rated load capacity of this crane allows ample margin of stability over any point of the chassis. The crane is fitted with fully slewing superstructure and can travel with load in any direction by use of patented reversible steering. It has a particular appeal to public works contractors and others requiring complete mobility, with the advantages of a heavy-duty static crane. This model lifts 12½ tons at 10-ft. radius with 30-ft. jib, down to 1 ton at 60-ft. radius with 80-ft. jib and outriggers in position.

Canadian Harbours

Large Increase in Trade during 1949

The following excerpts are taken from the fourteenth annual report of the National Harbours Board of Canada, covering the operations for the calendar year 1949:

SHIPPING AND CARGO TONNAGE

Vessels arriving in 1949 numbered 44,067, the aggregate net registered tonnage being 34,723,963. The comparable figures for 1948 were 43,627 vessels, aggregating 33,006,672 n.r.t.

The aggregate cargo tonnage in 1949 at all harbours administered by the Board was 33,713,796, as compared with 31,783,586 in 1948. The increase was 1,930,210 tons, or about 6 per cent. Foreign inward traffic decreased by 446,258 tons and foreign outward traffic increased by 635,966 tons, an aggregate increase in foreign traffic of 189,708 tons. Domestic inward traffic increased by 897,264 tons and domestic outward traffic increased by 843,238 tons, an aggregate increase of 1,740,502 tons.

The principal increase was in grain, which, counting inward as well as outward movements by water, totalled 8,266,173 tons in 1949 as compared with 4,575,440 tons in 1948, a gain of 3,690,733 tons or 81 per cent. Other substantial increases were noted in petroleum and petroleum products, anthracite coal, cement and iron ore. These increases were partially offset by reductions in bituminous coal, lumber, pulpwood, logs, wood-pulp, wheat flour and general cargo.

REVENUES AND EXPENDITURES

Operating Revenues. Exceeling those of any previous year, operating revenues of all units administered by the Board amounted to $14,072,697, ac compared with $12,830,784 in 1948. The increase was $1,241,913, or nearly 10 per cent. The chief factor in this favourable showing was the increase in grain traffic. The volume of grain handled in the nine elevators operated by the Board was 72 per cent. greater than in the previous year and earnings rose correspondingly. The increase in revenue from grain elevators, including rentals, was $1,625,000. Toll bridges also showed the substantial increase of $144,000. These gains were partially offset by reductions in earnings of wharves and piers, terminal railways, and cold storage warehouses. Wharves and piers produced receipts about 5 per cent. below those of 1948, attributable to the decline in general cargo.

Operating Expenses. Expenses of administration, operation and maintenance in 1949 were $8,160,622, as against $7,608,578 in 1948, an increase of $552,044, or 7 per cent. Operating expenses of grain elevators increased upwards of half-a-million dollars. Increased wages were also a factor in bringing current expenses to a record level. Outlay on maintenance of properties was $2,064,000, only slightly less than in the previous year.

Operating income showed a gain of $689,869, the comparable figures being $5,912,075 in 1949, as against $5,222,206 in 1948.

After taking into account debits and credits to income and charging interest and reserve for replacements, operations for 1949 resulted in a net income deficit of $1,493.517. This compares with a deficit of $2,042,353 in 1948. The deficit, therefore, decreased by $548,836, or 27 per cent.

Tariffs of Charges. As of August 1st, 1949, certain upward revisions in grain elevator charges became effective, in conformity

Canadian Harbours—*continued*

with maximum rates authorised by the Board of Grain Commissioners. Terminal railway charges at Vancouver were increased in some respects, effective September 1st, 1949. Otherwise, harbour charges were unchanged, notwithstanding increased costs of operation and maintenance.

Consolidated Statement—Seven Harbours. The operations of the Board fall into two divisions: first, the seven harbours administered by local Commissioners, prior to 1936, and secondly, the grain elevators at Prescott and Port Colborne and the harbour of Churchill, which were entrusted to the Board for operation at the beginning of 1937. Consolidated income statements for each of these divisions are set out below.

The seven harbours referred to—Halifax, Saint John, Chicoutimi, Quebec, Three Rivers, Montreal and Vancouver—had aggregate operating revenues in 1949 of $13,066,488, as compared with $12,179,849 in 1948. The increase was $886,639, or 7 per cent. Expenses of administration, operation and maintenance increased from $6,937,573 in 1948 to $7,376,641 in 1949, the difference being $439,068, or 6 per cent. Operating income increased from $5,242,276 in 1948 to $5,689,847 in 1949.

After taking into account income debits and credits and charging interest and reserve for replacements, a net income deficit of $1,717,375 was shown for these harbours in 1949, as compared with a deficit of $2,022,604 in the previous year.

During the period that these harbours have been under the administration of the Board, annual revenues have increased by $5,000,000, and operating expenses have risen by $2,900,000. The annual deficit position has shown an improvement of $4,100,000, due in part to the increase in operating income and in part to a reduction in interest rates on borrowed capital.

Prescott, Port Colborne and Churchill. Consolidated income statement for the grain elevators at Prescott and Port Colborne and the harbour of Churchill showed operating revenues of $1,006,209 in 1949, as compared with $650,935 in the previous year. Operating and maintenance expenses were $783,980 in 1949, as against $671,005 in 1948. These three units showed a surplus of $223,857 in 1949, as compared with a deficit of $19,749 in 1948. The improved outcome for the year arose out of the operations of the Prescott and Port Colborne grain elevators, the volume of business of which was more than double that of the previous year. Activity at Churchill was slightly greater than in 1948, grain shipments being 5,500,000 bushels, carried by sixteen vessels. Inward foreign cargo amounted to 2,000 tons. The accounts for these facilities do not include charges for interest or reserve for replacements, other than a small amount for interest on capital expended since these units were transferred to the Board.

Capital Expenditure. Work was commenced in 1949, on several new major construction projects involving a total expenditure to completion of about $5,750,000. These include a new pier at Halifax, wharf and shed reconstruction at Quebec, and wharf reconstruction and shed addition at Montreal. Expenditures incurred in 1949 on the above-mentioned and other capital and replacement works amounted to $4,837,091, of which $4,726,510 was charged to capital and $110,581 to reserve funds.

Notes of the Month

FISHING HARBOUR FOR PALESTINE.

A harbour for fishing boats will be built shortly at Neve-Reuven, south of Tel Aviv. It is planned that the new harbour will eventually relieve the Port of Tel Aviv of the congestion caused there by the fishing fleet.

IMPROVED FACILITIES AT THE PORT OF VIZAGAPATAM.

At a recent meeting of the Vizagapatam Port Advisory Committee, questions relating to improvement of facilities for handling manganese ore and coal were discussed. The Port Administration reported that larger tonnage of these commodities are being handled now than at any time since 1938 and stated that they were taking necessary action for the provision of additional cranes, locomotives, trucks and skips.

CARDIFF PORT ASSOCIATION.

Recent discussions on ways to expand trade at the Port of Cardiff have now reached a definite stage. A meeting of docks and town interests presided over by the President of the Cardiff Chamber of Commerce, at which the Lord Mayor of Cardiff was also present, formed an organisation to be known as the Cardiff Port Association. It will be representative of Cardiff Corporation, the various trade organisations, trade unions and individual firms. All local interests are to be approached for support and a meeting to proceed with the formal constitution of the Association is to be held in the near future.

DREDGING AT THE PORT OF SOUTHAMPTON.

Southampton Harbour Board has arranged with the Dredging & Construction Company, Ltd., King's Lynn, to begin work on dredging Southampton Water. The scheme, which will cost about £625,000 is expected to take 20 months to complete, and will provide a straight port-hand channel margin from the Solent to Calshot. It will include the deepening of the main Southampton Water Channel and the Middle and Lower Swinging Grounds. It has also been announced that the Dredging & Construction Company proposed to hire some of the plant from a local contractor who has hitherto done the Board's dredging. This will mean greater employment of local labour and the use of less of Dutch personnel.

DAR ES SALAAM HARBOUR WORKS.

Invitations for tenders in connection with the construction of two deep-water berths and ancillary works in Dar es Salaam are expected shortly. The cost will probably be about £1,500,000. The first berth is to be ready by the end of next year.

FLOATING DOCK FOR FALMOUTH.

A former German floating dock, which was brought to the Wear to be scrapped last November is being transferred to Falmouth, after having been taken over by the Admiralty, which has decided to put it into commission. The dock, which is 357-ft. in length, has been fitted out for its sea voyage by T. W. Greenwell & Co., Ltd., and recently left Sunderland in tow of the tug *Turmoil*.

PORT RADAR INSTALLATION AT SUNDERLAND.

Technicians are now completing the installation of a shore-based radar equipment at Sunderland Pilots' look-out house at the North dock, and it is expected to be ready for service almost immediately. It will be used to guide vessels into the harbour in thick fog. Equipment has been fitted by Henry Hughes & Son, Ltd., who will also erect a 50-ft. mast outside the pilot house to enable the pilots to " beam " their radar set 27 miles out to sea and for about half-a-mile up the river. Pilots will keep in touch with the pilot house by means of walkie-talkie two-way radio telephones.

DECCA MARINE RADAR.

Official Certificate of Type Approval has now been issued by the Ministry of Transport for Decca Marine Radar Type 159A. The issue of this Certificate is the result of nearly six months exhaustive tests carried out by the Admiralty Signal and Radar Establishment and denotes that the Decca Equipment meets the specification laid down by the Ministry of Transport. The tests carried out are extremely comprehensive and cover every aspect of the ship-borne use of the equipment, including performance, range, accuracy, operation and quality of components.

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